BACKGROUND DOCUMENT

Review of Waste Management Practices and Compliance History at Nuclear Power Plants and Other Entities that Generate Low-Level Mixed Waste

Prepared for:

U.S. Environmental Protection Agency
Office of Solid Waste
Permits and State Programs Division

Prepared by:

Hazardous and Medical Waste Services, Inc.
and
ICF Incorporated, Inc.

***** FINAL DRAFT DOCUMENT *****

October 14, 1998

VOLUME I

TABLE OF CONTENTS

Page

Volume I

TABLE OF CONTENTS (Continued)

Page

EXECUTIVE SUMMARY

INTRODUCTION

This background document was prepared to support the U.S. Environmental Protection Agency (EPA or Agency) in its analysis of the safeguards inherent in the U.S. Nuclear Regulatory Commission's (NRC) licensing program for nuclear power plants and other entities that store low-level mixed waste (LLMW) on site. EPA is conducting this analysis as part of its examination of the Agency's mixed waste enforcement policy and to address issues associated with the availability of LLMW treatment and disposal capacity. EPA will use the results of this analysis to support the development of potential options for providing regulatory relief from RCRA to the nuclear power industry and other industrial entities that both generate and store LLMW which is subject to NRC *and* EPA oversight. The Agency intends to discuss potential options for providing regulatory relief from RCRA in an Advanced Notice of Public Rulemaking in the near future. The resulting rulemaking is subject to court-ordered deadlines of October 31, 1999 for proposal and April 30, 2001 for promulgation stipulated in the Agency's settlement agreement with the Edison Electric Institute.

Information regarding the U.S. Nuclear Regulatory Commissions's regulations and requirements relating to the on-site treatment and storage of LLW at nuclear power facilities and other NRC licensed facilities that generate and subsequently store LLW on site was collected from the NRC's public document room, NRC's Internet site, NRC's regional staff, and several nuclear power utilities. Information characterizing historical violations related to the safety of on-site treatment and storage of LLW at nuclear power facilities and the on-site storage of LLW at other NRC licensed facilities also was collected from the NRC's public document room. Information relating to LLW then was used as a surrogate for assessing how LLMW was regulated and managed under the NRC's program (i.e., because NRC makes no distinction between LLW and LLMW -- both wastes are low level radioactive waste -- licensees must manage LLMW as if it was LLW).

NUCLEAR POWER FACILITIES

There are currently 110 commercial nuclear power reactors in the United States, of which 109 are operating in 32 States (one facility is closed and voted to start the decommissioning process in December, 1996). All nuclear power reactors are licensed directly by the NRC under the authority of the Atomic Energy Act, as amended, and Title 10 of the Code of Federal Regulations.

The NRC regulates civilian uses of nuclear materials through the issuance of performance-based regulations, regulatory guides, generic communications, and NUREGs. NRC uses the various regulatory guides, generic communications, and NUREGs to guide licensees on how to meet the intent of the regulations. These documents work together to enable the NRC to ensure that nuclear power facilities are operating in a manner that is safe to both human health and the environment.

NRC Regulations

NRC regulations of interest are found at 10 CFR Chapter I -- Nuclear Regulatory Commission; a partial listing of the parts most relevant to the construction and operation of nuclear power facilities and the management of radioactive waste includes:

10 CFR 20 - Standards for Protection Against Radiation
10 CFR 50 - Domestic Licensing of Nuclear Reactors or Fuel Reprocessing Plants
10 CFR 50
Appendix A -"General Design Criteria for Nuclear Power Plants"
10 CFR 50
Appendix I - "Numerical Guides for Design Objectives and Limiting Conditions for Operation Guides to Meet the Criterion as Low as is Reasonably Achievable for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents"
10 CFR 61 - Licensing Requirements for Land Disposal of Radioactive Waste
10 CFR 70 - Domestic Licensing of Special Nuclear Material
10 CFR 71 - Licensing of the Packaging and Transportation of Radioactive material

In general, the management of LLW is subject to a broad range of regulatory provisions. Licensees of nuclear power plants are required by NRC's general radiation protection standards (10 CFR Part 20) to ensure that radioactivity levels released to the environment are as low as reasonably achievable (ALARA).[1] Portions of 10 CFR Part 20 (Subpart K) also pertain to waste disposal, which is allowed by the NRC only by (1) transfer to an authorized recipient; (2) decay in storage; or (3) release in effluents, but only if within specified dose limits. Authorized recipients of waste, in turn, must be specifically licensed for one or more of the following waste management alternatives:

- Treatment prior to disposal;
- Treatment or disposal by incineration;
- Decay in storage;
- Disposal at a land disposal facility licensed under 10 CFR Part 61; or
- Disposal at a geologic depository licensed under 10 CFR Part 60.

The 10 CFR 50 regulations pertain to the process of obtaining a construction permit; preparing a license application, which also includes the preliminary and final safety analysis reports; and the controlling, monitoring, and reporting of the release of radioactive materials to the environment. Appendix A of Part 50 stipulates the "General Design Criteria for Nuclear Power Plants," which are provided as criteria. The relevant criteria include:

- **Criterion 60** -- *Control of Releases of Radioactive Materials to the Environment.* "The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be

[1] Waste management is also subject to standards set by EPA under 40 CFR Part 190.

expected to impose unusual operational limitations upon the release of such effluents to the environment."

- **Criterion 61** -- *Fuel Storage and Handling and Radioactivity Control*. "The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions."

- **Criterion 63** -- *Monitoring Fuel and Waste Storage*. "Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions."

- **Criterion 64** -- *Monitoring Radioactivity Releases*. "Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculating of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents."

The disposal and transportation of radioactive wastes are covered in 10 CFR 61 and 71, respectively.

Regulatory Guides

NRC uses Regulatory Guides to describe acceptable methods of implementing NRC regulations and the specific Regulatory Guide of interest for nuclear power facilities is:

- **Regulatory Guide 1.143** - "*Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants*," Revision 1, October, 1979. NRC prepared this guide to provide information and criteria that will provide reasonable assurance that components and structures used in the radioactive waste management and steam generator blowdown systems are designed, constructed, installed, and tested on a level commensurate with the need to protect the health and safety of the public and plant operating personnel. It also set forth minimum staff recommendations and was not intended to prohibit the implementation of more rigorous design considerations, codes, standards, or quality assurance measures. A summary of the minimum design criteria set forth by the guide for systems handling radioactive liquids, gases, and solid wastes include the following:

- **Compatibility**. Construction materials should be compatible with the chemical, physical, and radioactive environment of specific applications during normal conditions and anticipated operational occurrences.

- **Structural Design Criteria**. Foundations and walls of structures that house the radwaste systems should be designed to withstand seismic events and be of height sufficient to contain the maximum liquid inventory expected to be in the building.

- **Spill Controls**. Radioactive waste management structures, systems, and components should be designed to control leakage and facilitate access, operation, inspection, testing, and maintenance in order to maintain radiation exposures to operating and maintenance personnel as low as is reasonably achievable.

Generic Communications

NRC issues generic communications (bulletins, generic letters, information notices, and administrative letters) to inform groups of licensees about specific problems, developments, or other matters of interest to the licensees. NRC also uses generic letters to request licensees to take specific actions or require them to submit information. Several of the more important generic communications of interest to nuclear power facilities concerning the management of radioactive wastes include:

- **IE Circular No. 80-18**, "*10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems,*" August, 1980. In this document, NRC clarified the requirements of 10 CFR 50.59, which addresses the types of changes the licensee is able to make to the facility and its operation as described in the Safety Analysis Report (SAR) without prior approval, provided that a change in Technical Specifications is not involved or an "unreviewed safety question" does not exist. Specifically, a safety evaluation is required if the following circumstances occur: (1) components described in the SAR are removed; (2) component functions are altered; (3) substitute components are utilized; or (4) changes remain following completion of a maintenance activity.

- **Generic Letter 81-38**, "*Storage of Low-Level Radioactive Wastes at Power Reactor Sites," and Enclosure, "Radiological Safety Guidance for Onsite Contingency Storage Capacity,*" November 10, 1981. In this generic letter, NRC discusses its position on proposed increases in storage capacity for low-level wastes generated by normal reactor operation and maintenance and stated that the safety of the proposal must be evaluated by the licensee under the provisions of 10 CFR 50.59. The NRC also attached a radiological safety guide to this letter. This guide was developed for the design and operation of interim contingency low-level waste storage facilities, and that necessary design features and administrative controls would be dictated by such factors as the waste form, concentrations of radioactive material in individual waste containers, total amount of radioactivity to be stored, and retrievability of waste. NRC also noted that this guidance document should be used in the design, construction and operation of storage facilities and that the NRC would judge the adequacy of 10 CFR Part 50.59 evaluations based on compliance with the guidance. (NRC also referenced IE Circular No. 80-19, dated

August 22, 1980, as providing information on preparing 50.59 evaluations for changes to radioactive waste treatment systems).

- **Generic Letter 85-14**, *"Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility,"* August 1, 1985. NRC, in this letter, stated that licensees should ship waste for disposal, rather than storing the waste on site, to the maximum extent practicable. NRC also indicated that it recognized that storage may appear desirable in states which have not resolved their low-level waste disposal problems, however, commercial storage facilities should not become *de facto* disposal sites. Lastly, in order for NRC to consider any proposal for commercial storage at a reactor site, including commercial storage in existing low-level waste storage facilities, the NRC stated that it must be convinced that no significant environmental impact will result.

- **Generic Letter 80-051**, *"Letter to Licensees Concerning On-Site Storage of Low-Level Waste,"* and Enclosure *"Safety Consideration for Temporary On-Site Storage of Low-Level Radioactive Waste,"* June 9, 1990. In this generic letter, NRC stated that the Licensee must assure that the design and operation of proposed on-site storage facilities are adequate to maintain public health and safety, minimal risk to operating personnel, and present a minimal environmental impact. NRC also indicated that any decision to incorporate on-site storage requires a 10 CFR 50.59 safety review of the areas of (1) Radioactive Material and Effluent Control, (2) Radiation Dose Control for both on-site and off-site individuals, and (3) for "Safety Considerations for Temporary On-Site Storage. Lastly, NRC provided an enclosure, "Safety Consideration for Temporary On-Site Storage of Low-Level Radioactive Waste," which was modeled after NRC's previous guidance, entitled *Radiological Safety Guidance for Onsite Contingency Storage Capacity,*" (presented in Generic Letter 81-38). This guided limited the duration of temporary material storage to up to four years and addressed the storage of wet waste, solidified wet waste, and dry low-level radioactive waste. Minimum design and operating criteria were also provided.

NRC Reports

NRC prepares reports on a wide ranch of topics including:

- Ongoing regulatory proceedings, such as safety evaluation reports and environmental impact statements.

- Technical and regulatory reports of general applicability, such as information supporting regulatory decisions, guidance for meeting NRC regulations, results of task force investigations of specific topics or incidents, analyses of certain regulatory programs, proceedings of conferences and workshops, and administrative information of interest to the staff, the industry, and the public.

- Standard review plans and application guidance to make information about the regulatory licensing process widely available and to improve the understanding of the staff's review process widely available and to improve the understanding of the staff's review process for interested members of the public and the nuclear industry.

These documents are designated as NUREGs and specific NUREG documents of interest for nuclear power plants include:

- **NUREG-0800**, *"Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR (Light Water Reactor), Edition,"* July, 1981 (as updated). The Standard Review Plan (SRP) is prepared for the guidance of staff reviewers in the Office of Nuclear Reactor Regulation in performing safety reviews of applications to construct or operate nuclear power plants. The principal purpose of the SRP is to assure the quality and uniformity of staff reviews and to present a well-defined base from which to evaluate proposed changes in the scope and requirements of reviews. The SRP also is used to ensure that the design provisions incorporated in the equipment and facility design to reduce leakage and facilitate operation and maintenance meet the intent of NRC's Regulatory Guideline 1.143.

- **Management Directive 8.6** - *"Systematic Assessment of Licensee Performance (SALP)."* This document explains how the NRC uses the Systematic Assessment of Licensee Performance (SALP) process to articulate the agency's observations and insights on the licensee's safety performance. The SALP report communicates those observations and insights to licensee management and the public.

- **Various Inspection Procedures Utilized by NRC**. NRC has prepared numerous inspection procedures to enable NRC inspectors to determine whether the radwaste treatment and storage facilities and procedures are adequate and meet the intent of the various regulations, guides, and generic communications concerning the management of radwaste. These procedures cover factors such as whether:

  - the licensee has provided an adequate safety evaluation for construction and operation of the facility
  - quality assurance plans, instructions, and procedures have been established.
  - adequate construction procedures have been established
  - construction of the as-built facility was consistent with NRC requirements and licensee commitments
  - changes to organization and staffing because of the LLRW storage facility agree with applicable requirements of the Technical Specifications and with FSAR and other licensee commitments
  - effective training and qualification programs exist for personnel assigned to the LLRW storage facility
  - adequate procedures have been established for routine operation of the LLRW storage facility
  - there have been any changes to the facility and facility operations that could affect effluent monitoring requirements.

A preliminary review of the NRC's regulations, regulatory guides, generic communications, and other NRC documents concerning the storage and treatment of LLW at nuclear power plants, suggests that the NRC's design and operating requirements are sufficient to protect human health and the environment from releases of radioactive materials and provide substantial protection against the mismanagement of hazardous wastes.

To obtain a better understanding of how LLW were managed at nuclear power facilities and to gauge whether nuclear power plants were in compliance with all applicable requirements,12 nuclear power plants were randomly selected on a stratified basis to represent the distribution of reactors by NRC Region and reactor design for further study. Copies of the NRC operating license for each of the 12 facilities were obtained from the NRC's public document room. These licenses were reviewed to identify if any of the licenses contained conditions (or requirements) concerning the on-site management (treatment and storage) of low-level radioactive waste at the plants.

Based on this review, it was observed that all of the licenses were general in nature and contained the following statement: "...license shall be deemed to contain and is subject to the conditions specified in the commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect." The licenses also stated that the requirements, procedures, and specifications stipulated in the Technical Specifications and the Environmental Protection Plan submitted by the licensee were incorporated in the license. (The Technical Specifications detail the operation of the plant and the Environmental Protection Plan ensures that the plant is operated in an environmental acceptable manner in accordance with the plant's Final Environmental Statement and other federal, state, and local requirements for environmental protection.)

It should be noted that as part of the licensing process, the applicant submits an application for an operating license (which is granted in two phases - construction permit and operating license). The application must contain all of the information required by 10 CFR 50.33. In addition, as per 10 CFR 50.34, the applicant also must present a Safety Analysis Report, which in the initial phase of licensing is termed the "Preliminary Safety Analysis Report (PSAR). The PSAR must be sufficiently detailed to permit the NRC to determine whether the plant can be built and operated without undue risk to the health and safety of the public. Prior to submission of an PSAR, an applicant should have designed and analyzed the plant in sufficient detail to conclude that it can be built and operated safely.

The SAR is the principal document in which the applicant provides the information needed to understand the basis upon which this conclusion has been reached. Section 50.34 specifies, in general terms, the information to be supplied in a SAR. The specific information required by the staff for an evaluation of an application is identified in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants - LWR Edition." The Standard Review Plan (SRP) sections are keyed to the Standard Format, and the SRP sections are numbered according to the section numbers in the Standard Report.

The NRC uses NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," to guide their review of the applicant's PSAR. If the PSAR is determined to be adequate, and after a public comment process, the NRC grants a construction permit (CP). The applicant can then begin construction of their nuclear power plant.

Once the construction of the nuclear power plant has reached the point where all of the design details have been worked out and the plans for operation of the facility have been finalized, the applicant then submits, as an amendment to their initial application), a Final Safety Analysis Report (FSAR) to the NRC for review. If the NRC determines that an operating license should be granted, the NRC holds a public hearing, resolves any public concerns, and then grants an operating license.

Copies of the Final Safety Analysis Report (FSAR), which is the principal document in which the applicant provides the information needed by the NRC to determine if the applicant has designed and analyzed the plant in sufficient detail for the NRC to conclude that the plant can be built and operated safely, were obtained for each of the 12 study facilities from the NRC's public document room. The relevant sections of each FSAR were reviewed to identify how the liquid, gaseous, and solid radioactive wastes were being managed at the sites. Based on a preliminary review of the relevant sections of the FSARs for each of the 12 study facilities, it appears as though the radwaste treatment and storage areas have been designed and operated in accordance with the applicable NRC regulations concerning the treatment and storage of LLW at nuclear power plants.

To get a better understanding of the facility's performance of activities associated with occupational radiation safety, radioactive waste management, radiological effluent control and monitoring, transportation of radioactive materials, and housekeeping, NRC's Systematic Assessment of Licensee Performance (SALP) reports were obtained for each of the 12 study facilities. NRC uses the SALP process to articulate the agency's observations and insights on the licensee's safety performance. During the SALP, NRC Regional Inspectors work with the NRC Resident Inspectors to conduct a comprehensive examination of the operations at the specific nuclear power plant. The SALP reports were reviewed and relevant findings regarding the facility's performance were extracted. Nine of the 12 facilities received a "superior" performance rating in the area of Plant Support (includes waste management activities), and the remaining three facilities receive a "good" performance rating.

NRC Regional Inspectors also conduct periodic inspections of the plants's solid radioactive waste management and transportation of radioactive materials program following NRC's Inspection Procedure 86750. Copies of recent inspection reports were obtained for each of the study facilities. These inspection reports were reviewed for observations regarding waste management practices.

Based on a review of the inspection reports prepared for the 12 study facilities, it appears as though the solid radioactive waste management programs are being effectively managed and implemented at all of the sites, with two exceptions. First, a recent incident has resulted in the NRC's issuance of a notice of violation for Fort Calhoun Station. Specifically, during the July 1998 inspection, NRC Inspectors noted that:

- “Dry active waste samples were not taken annually. Dry active waste stream samples were collected in June 1995 and August 1997.”

- “Off-site laboratory results of the dry active waste stream were not compared with Fort Calhoun gamma isotopic results for the same waste stream sample to verify consistency between the two analyses from August 1995 to July 1998.”

- “Annual off-site laboratory waste stream sampling results for the dry active waste stream were not compared with the previous year’s results for the same waste stream from August 1995 to July 1998.”

- “Scaling factors for the dry active waste stream were not updated from August 1995 to July 1998.

NRC, therefore, issued a notice of violation that Fort Calhoun has 30 days to state: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved.

The second incident occurred during a March 1997 inspection at Palisades Nuclear Generation Plant. Specifically, due to the lack of adequate procedural guidance for determining, controlling, and logging the volume of spent resin handled in the solid radioactive waste system, the spent resin storage tank was overfilled and spent resin entered the equipment drain system downstream of the storage tank. NRC issued a notice of violation requesting the Palisades plant to respond in 30 days and to state: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved.

To further investigate the compliance history (last five years) of all nuclear power facilities, the following NRC documents were reviewed:

- Office of Enforcement Annual Report - Fiscal Year 1996, U.S. NRC, rev. 1/97
- Office of Enforcement Annual Report - Fiscal Year 1997, U.S. NRC
- Escalated Enforcement Actions Issued Since March 1996 for Material Licensees (Last updated August 11, 1998), U.S. NRC
- Escalated Enforcement Actions Issued Since March 1996 for Reactor Licensees (Last updated August 14, 1998), U.S. NRC
- Enforcement Actions and Significant Actions Resolved - NUREG 0940 (Yearly, quarterly, violations summaries for Material Licensees, Medical Licensees, and Reactor Licensees, U.S. NRC
- Inspection reports stored at the NRC Public Document Room (PDR), located through the PDR database

Violations that dealt with storage, disposal, and management of radioactive waste were selected for further review. Whereas, violations that dealt with the loss or misplacement of radioactive materials, or components containing radioactive materials (e.g., gauges), that had not specifically been identified as a waste were excluded. Only five violations were noted. Four of the five dealt with packaging or shipping of wastes, and the fifth violation was related to an accidental release of contaminated waste water. None of the violations in the last five years were associated with the improper storage or disposal of radioactive wastes.

Despite the occurrence of these minor incidents, the preliminary review of NRC's compliance records for both the study group and all nuclear power plants, appears to indicate that there is overwhelming evidence to document that these facilities are complying with the NRC regulatory requirements concerning the storage (and treatment of LLMW).

OTHER ENTITIES

NRC also ensures that civilian uses of nuclear materials are carried out with adequate protection of the public health and safety, of the environment, and of national security at Industrial Facilities, Medical/Academic Institutions, and Government Facilities. A total of 21,685 licenses have been issued for medical, academic, and industrial uses of nuclear material; 5,961 licenses are administered by the NRC and the remaining 15,724 licenses are administered by the 30 States that participate in the NRC Agreement States Program.

Agreement states are states that have signed agreements with the NRC allowing them to regulate the use of radioactive material within their state. Other states that have applied for the Agreement States Program include Ohio, Pennsylvania and Oklahoma. At this point in time, thirty states have signed agreements with NRC enabling the various "Agreement States" to regulate source, byproduct, and small quantities of special nuclear material within their boundaries.

Most facilities located in Agreement States are subject to regulatory requirements for radioactive material under state law. This applies to all source, special nuclear, and byproduct material except that from nuclear utilities and fuel cycle facilities, which are subject to NRC's requirements and DOE facilities, which are subject to DOE Orders. While states are required to adopt programs that are comparable with the NRC program, states may also adapt more stringent programs in addition to their comparable Federal NRC program.

Material licensees are regulated by the NRC (and if applicable, Agreement State), which has issued numerous performance-based regulations, regulatory guides, generic communications, NUREGs, and other documents. As was described for nuclear power plants, NRC uses the various regulatory guides, generic communications, and NUREGs to guide licensees on how to meet the intent of the regulations. These documents work together to enable the NRC to ensure that material licensees are managing LLW in a manner that is safe to both human health and the environment.

NRC Regulations

NRC regulations of interest for material licensees are found at 10 CFR Chapter I -- Nuclear Regulatory Commission. A partial listing of the parts most relevant to the management of radioactive waste by material licensees includes:

10 CFR 20 - Standards for Protection Against Radiation
10 CFR 30 - Rules of General Applicability to Licensing of the Possession or Use of Nuclear or Byproduct Material in Medicine, Industry (including Low-Level Waste Management at Power Reactors), Agriculture, or Research
10 CFR 35 - Medical Use of Byproduct Material
10 CFR 40 - Domestic Licensing of Nuclear Source Material Facilities
10 CFR 71 - Licensing of the Packaging and Transportation of Radioactive material

As stated earlier, the management of low-level radioactive waste is subject to a broad range of regulatory provisions. Licensees are required by NRC's general radiation protection standards (10 CFR Part 20) to ensure that radioactivity levels released to the environment are as low as reasonably achievable (ALARA).[2] Portions of 10 CFR Part 20 (Subpart K) also pertain to waste disposal, which is allowed by the NRC only by (1) transfer to an authorized recipient; (2) decay in storage; or (3) release in effluents, but only if within specified dose limits. The disposal and transportation of radioactive wastes are covered in 10 CFR 61 and 71, respectively.

Regulatory Guides

Specific Regulatory Guides of interest to material licensees include:

- **Regulatory Guide 8.18** - "*Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable,*" Revision 1, October, 1982. NRC prepared this guide especially for medical licensees and recommends methods acceptable to the NRC for maintaining occupational exposures as low as is reasonably achievable (ALARA) in medical institutions. This guide also discusses the functions and qualifications of the radiation safety office and personnel, including the Radiation Safety Officer.[3] Lastly, the guide also discusses the need for adequate storage space locations, equipment, and shielding, including the use of a specially shielded waste receptacle for used syringes and other radioactive wastes in the nuclear medicine laboratory.

- **Regulatory Guide 10.2** - "*Guidance to Academic Institutions Applying for Specific Byproduct Material Licenses of Limited Scope,*" Revision 1, December, 1976. NRC prepared this guide to describe the type of information that should be submitted in the applications for specific licenses of limited scope for the possession and use by academic institutions of byproduct material. It includes the general principles that will be considered in evaluating an applicant's proposed radiation safety measures. It requests the applicant to describe training programs, facilities and equipment, storage areas, storage requirements, labeling, and waste disposal procedures within the laboratory.

---

[2] Waste management is also subject to standards set by EPA under 40 CFR Part 190.

[3] The title "Radiation Safety Officer," used by many medical licensees, is used to designate the qualified individual who is responsible for carrying out the institution's radiation safety program.

- **Regulatory Guide 10.4** - "*Guide for the Preparation of Applications for Licenses to Process Source Material,*" Revision 2, December, 1987. NRC prepared this guide to provide assistance to applicants and licensees in preparing applications for new licenses, license amendments, and license renewals for the use of source material in such activities as research and development, the use of source materials as shielding, manufacturing depleted uranium and thorium-magnesium alloy products, manufacturing glass containing uranium, manufacturing and distributing other products containing source material, or shaping, grinding, and polishing lenses containing thorium. It requests the applicant to provide the same types of information requested in Regulatory Guide 10.2 and also asks the applicant to describe provisions for monitoring and segregating waste materials (radioactive from nonradioactive and liquid from solid waste).

- **Regulatory Guide 10.5** - "*Applications for Type A Licenses of Broad Scope,*" Revision 1, December, 1980. NRC prepared this guide to describe the type of information that should be submitted in the applications for specific licenses of broad scope for the possession and use by academic institutions having an extensive byproduct material management program. This license is the most comprehensive issued and may be written to cover a wide range of radionuclides (e.g., all radionuclides with atomic numbers 1 through 83) for use under the control of a radiation safety committee. It includes the general principles that will be considered in evaluating an applicant's proposed radiation safety measures. In addition to requesting the same type of information cited in Regulatory Guide 10.2, it requests the applicant to describe facilities and equipment; storage areas; storage requirements; labeling; procedures for disposing of byproduct material waste; standard operating procedures; and procedures for maintaining inventories of all radioisotopes at the institution and limiting the quantity of radionuclides at the institution to the amounts authorized by the license.

Generic Communications

Generic communications of interest include:

- **Information Notice No. 89-13**, "*Alternative Waste Management Procedures in Case of Denial of Access to Low-Level Waste Disposal Sites*." The purpose of this notice was to inform addressees of potential restrictions on disposal of low-level radioactive waste, and to suggest actions to minimize possible adverse consequences of these events if licensed activities involve the need to dispose of radioactive waste.

- **Information Notice No. 90-09**, "*Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Material Licensees*," and Attachment, "*Information Needed in an Amendment Request to Authorize Extended Interim Storage of Low-Level Radioactive Waste*," February 5, 1990. The purpose of this information notice was to provide guidance to materials licensees on information needed in license amendment requests to authorize extended interim storage of low-level radioactive waste (LLW) at licensed operations. The NRC stated that storage was not a substitute for disposal, and that other than storage for radioactive decay, LLW should be stored only when disposal capacity is unavailable and for no longer than is necessary. NRC also addressed requirements for waste processing, packaging, storage, shielding, inspection, potential waste incompatibilities and reactions, and security. Lastly, NRC stated that in the interest of public health and safety, as well as maintaining exposures ALARA, the length of time LLW is placed in storage should be kept to a minimum (generally be for a period of time no greater than five years).

- **Policy and Guidance Directive 94-05**, "*Updated Guidance on Decay-In-Storage*," October 19, 1994. The purpose of this policy and guidance directive was to explain that the Division of Waste Management (DWM) was conducting a generic assessment to determine the survey and activity criteria necessary to dispose of radioactive material by decay-in-storage (DIS) pursuant to 10 CFR 2001(a)(2), and that until the generic assessment was completed, NRC regions could routinely grant new or renewal requests for DIS authorizations which met the requirements of 10 CFR 35.92 (a)(1), (a)(2), (a)(3), (a)(4), and (b). NRC noted that although DWM previously concluded that materials with half-lives of 120 days are appropriate for DIS after a minium of 10 half-lives of 120 days, if appropriate surveys were conducted to establish that residual activity is indistinguishable from background, that authorizations for DIS could be granted by the regions for isotopes with half-lives of less than or equal to 120 days without NMSS review pending completion of the assessment.

NRC Reports

Specific NUREG documents of interest includes **NUREG -SR1556**, "*Consolidated Guidance About Material Licenses*":

- **NUREG-SR1556, V1**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about Portable Gauge Licenses.*"

- **NUREG-SR1556, V2**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about Industrial Radiography Licenses.*"

- **NUREG-SR1556, V6**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about 10 CFR Part 36 Irradiator Licenses.*"

- **NUREG-SR1556, V7**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about Academic, Research and Development, and other Licenses of Limited Scope.*"

  The purpose of these documents is to explain the information requested (or contents) in the license application for material licenses for the various types of facilities. These documents explain the need for a qualified Radiation Safety Program and Radiation Safety Officer, and discusses how licensees must manage radioactive waste generated at their facilities.

- **Various Inspection Procedures Utilized by NRC**. NRC has prepared numerous inspection procedures to enable NRC inspectors to determine whether the radwaste treatment and storage facilities and procedures are adequate and meet the intent of the various regulations, guides, and generic communications concerning the management of radwaste. These procedures cover factors such as whether:

-- the licensee has established and is maintaining adequate management-controlled procedures and quality assurance that reasonably ensure compliance with the requirements of 10 CFR Part 20 and 10 CFR Part 61 applicable to low-level radioactive waste (radwaste) form, classification, stabilization, and shipment manifests/tracking.

-- waste is stored and controlled in a secure and safe manner, and that radiation levels in unrestricted areas surrounding the storage area do not exceed the limits of 10 CFR 20.1301, "Dose limits for individual members of the public." Verify that disposals of decay-in-storage waste are performed in accordance with the regulations and license conditions. (Note that licensees, other than medical, must be specifically authorized in the license to dispose of waste by decay-in-storage.) Verify that the licensee is conducting appropriate surveys and defacing radioactive material labels before disposing of the waste.

-- the licensee has an accounting system that suits the type of licensed program. For example, a relatively small facility will generally need to maintain receipt records, disposal records, and records of any transfers of material. However, a large facility will need a sophisticated accounting system for all licensed material that provides accurate information on the receipt, location, the quantity used and disposed of, the amount transferred to other laboratories operating under the same license, and the amount remaining after decay. The accounting systems should also consider licensed material held for decay-in-storage, near-term disposal, or transfer to other licensees. In both types of accounting systems, the licensee should perform routine physical audits, to ensure the accuracy of the system.

-- the licensee's procedures and records are sufficient to document that each shipment of radwaste intended for offsite disposal is accompanied by a shipment manifest that includes all the required information.

-- the licensee's procedures and records are sufficient to document that each package of radwaste intended for shipment to a licensed land disposal facility is labeled, as appropriate, to identify it as Class A, B, or C waste (in accordance with the classification criteria of 10 CFR 61.55 [Subsection III.A.2 of Appendix F to 10 CFR 20.1001-20.2401]).

-- the waste-handling equipment, monitoring equipment, and/or administrative controls are adequate to maintain radioactive effluents within the limits established by the license and other regulatory requirements and are ALARA, and that the licensee's air effluents, excluding Radon-222 and its daughters, have not exceeded the constraint limit in 10 CFR 20.1101. If the licensee has exceeded the constraint, the inspector verifies that the licensee has notified the NRC as required by 10 CFR

20.2203. If the licensee has notified the NRC that its air effluents have exceeded the constraint limit, the inspector reviews the effectiveness and timeliness of the licensee's corrective actions.

-- the quality of the relevant procedures and the degree to which ALARA techniques are incorporated into them, and the extent to which process and engineering controls are used to minimize effluents.

-- the effluent monitoring systems and the associated analytical equipment are adequate to detect and quantify effluents with sufficient sensitivity, and whether they are maintained, calibrated, and operated in accordance with manufacturers' recommendations and good health physics practices.

-- all significant release pathways are monitored, all un-monitored pathways have been characterized, and all surveillance procedures for effluents are being implemented.

-- the wastes are transferred to an authorized recipient specifically licensed to receive radioactive waste and that records of waste storage, transfer, and disposal are maintained in accordance with the requirements of 10 CFR Part 20 and the license.

A preliminary review of the NRC's regulations, regulatory guides, generic communications, and other NRC documents concerning the storage of LLW by material licensees, suggests that the NRC's design and operating requirements are sufficient to protect human health and the environment from releases of radioactive materials and provide substantial protection against the mismanagement of hazardous wastes.

The NRC has direct regulatory oversight responsibilities for all material licensees in those states that have opted to allow NRC to provide regulatory and licensing oversight; these states are referred to as Non-Agreement States. The NRC allows for all non-agreement state inspection or violations-related information (and correspondence) to be publicly available. The NRC, however, has very limited information on material licensees operating in those states that have an agreement with NRC to provide their own regulatory and licensing oversight; these states are referred to as agreement states.

To investigate the compliance history (last five years) of material licensees in Non-Agreement States, the following NRC documents were reviewed:

- Office of Enforcement Annual Report - Fiscal Year 1996, U.S. NRC, rev. 1/97
- Office of Enforcement Annual Report - Fiscal Year 1997, U.S. NRC
- Escalated Enforcement Actions Issued Since March 1996 for Material Licensees (Last updated August 11, 1998), U.S. NRC
- Escalated Enforcement Actions Issued Since March 1996 for Reactor Licensees (Last updated August 14, 1998), U.S. NRC

- Enforcement Actions and Significant Actions Resolved - NUREG 0940 (Yearly, quarterly, violations summaries for Material Licensees, Medical Licensees, and Reactor Licensees, U.S. NRC
- Inspection reports stored at the NRC Public Document Room (PDR), located through the PDR database.

Violations that dealt with storage, disposal, and management of radioactive waste were selected for further review. Whereas, violations that dealt with the loss or misplacement of radioactive materials, or components containing radioactive materials (e.g., gauges), that had not specifically been identified as a waste, were excluded. A total of 23 violations were noted, with several licensees being cited multiple times for violations regarding improper radioactive waste disposal, storage and auditing (surveying) practices. Of the 23 violations, only two dealt with failures to abide by storage time limitations (e.g., storing radioactive waste for longer than 180 days). The majority of violations (11) were noted at medical institutions, which were primarily cited for improper disposal of radioactive waste.

To investigate the compliance history of material licensees in Agreement States, the following reports were analyzed:

- Integrated Materials Performance Evaluation Program (IMPEP) NRC Reviews for: Arkansas (1998), Louisiana (1996), Iowa (1996), Illinois (1997), Georgia (1996), Maryland (1996), Colorado (1997), North Carolina (1995), New Hampshire (1997), Nevada (1997), California (1996), Nebraska (1996), Mississippi (1997), North Dakota (1996), Tennessee (1996), Utah (1994), Texas (1997)

As was done for material licensees in non-agreement states, only violations that dealt with storage, disposal, and management of radioactive waste were selected for further review. Violations that dealt with the loss or misplacement of radioactive materials, or components containing radioactive materials (gauges), that had not specifically been identified as a waste were excluded. From the information found in 17 IMPEP state reports reviewed, a total of 17 violations involving problems with storage or disposal of radioactive waste occurred in five states. The majority of these violations (10 of 17) dealt with the improper disposal of waste. Specifically, low activity waste was simply co-disposed with the non-radioactive waste streams instead of following proper disposal procedures for radioactive waste. As was found in the analysis of the Non-Agreement States, medical institutions had the most violations. None of the violations were for cases where LLW had been stored longer than the allowable period.

Comparison of the Frequency of NRC LLW Violations to RCRA Violations

To provide a baseline for the comparison of NRC LLW violations, two of EPA's generator information management systems - - the Biennial Reporting System (BRS) and the Resource Conservation and Recovery Information System (RCRIS) - - were queried to obtain the number of RCRA violations.

Using BRS data for 1995, 18,497 facilities were identified as having generated hazardous waste (including permitted small quantity generators). These "records" were merged with the information from RCRIS and then sorted by RCRIS violation area codes. The violations were sorted by grouping (generator, other, treatment, and transporter) and by state. Based on this process, a total of 4,547 violations were caused by a total of 1,352 facilities (or 7.3% of the 18,497 permitted facilities). Of the 4,547 violations, 3,355 resulted from the non-compliance with the generator requirements (manifesting, recordkeeping, time-in-storage, reporting, etc.), and of the 3,355 generator violations, 142 involved mixed waste. Although a direct comparison is not possible (because compliance information could not be obtained for every material licensee), it should be noted that the number of violations reported (on a percentage basis) by NRC for both nuclear power reactors and material licensees compares favorably with the percentage of violations reported by EPA.

Background Document Summarizing the NRC License Requirements and Historical Data on Radiation Management Violations

1.0 Purpose

The purpose of this background document is to: (1) summarize the U.S. Nuclear Regulatory Commissions's regulations and requirements relating to the treatment and storage of LLW at nuclear power facilities and other NRC licensed facilities that generate and subsequently store LLW, and (2) document historical data on licensee violations related to the safety of on-site treatment and storage of LLW at nuclear power facilities and other NRC licensed facilities.

1.1 The U.S. Nuclear Regulatory Commission

The U.S. Nuclear Regulatory Commission (NRC) was established as an independent agency by the Congress under the Energy Reorganization Act of 1974 to ensure that civilian uses of nuclear materials in the United States--in the operation of nuclear power plants, and in medical, industrial, and research operations--are carried out with adequate protection of the public health and safety, of the environment, and of national security. NRC is headquartered in Rockville, Maryland and has four regional offices located throughout the United States. The agency also operates a technical training center located in Chattanooga, Tennessee.

NRC carries out its mission through various licensing, inspection, research, and enforcement programs. Currently, NRC responsibilities include regulating 110 commercial nuclear power reactors; 43 non-power reactors, 8 major uranium fuel cycle facilities; 2 uranium enrichment gaseous diffusion plants, and approximately 21,600 licenses issued for medical, academic, and industrial uses of nuclear material (includes Agreement States). The NRC is also overseeing the decommissioning of 15 nuclear power reactors that it regulates. The audit and investigative universe is, therefore, comprised of a myriad of programs, functions, and support activities established to carry out NRC's mission.

The Reactor Program is conducted by various headquarters and regional office organizations. The Office of Nuclear Reactor Regulation (NRR) is responsible for ensuring that (1) nuclear power plants are designed and constructed properly, (2) licensees operate the facilities safely and are capable of responding adequately to an accident, and (3) reliable safeguards are in place to prevent unauthorized use of nuclear materials.

The operating reactor inspection program is conducted by headquarters and regional office inspectors. NRC's four regional offices direct the preponderance of NRC's inspection program, and use about 400 inspectors to oversee reactor operations and assess whether licensees are complying with regulatory requirements and individual plant technical specifications. These include resident inspectors who are generalists in plant operations and are located at each nuclear power plant, and region-based inspectors who are specialists in certain inspection disciplines. The nature of NRC's inspections varies, from a resident's daily surveillance of plant activities, to team inspections that follow up on abnormal plant events.

NRC's Office of Nuclear Regulatory Research (RES) is responsible for assisting in developing regulations, technical operating standards and requirements, and resolving generic safety issues. RES also recommends and contracts for research deemed necessary by the Commission to support reactor licensing and other related regulatory functions. RES provides independent expertise for making regulatory judgements, anticipates problems of potential safety significance for which new or expanded knowledge can assist NRC in pursuing its mission, and develops regulatory guidance to implement Commission policy.

Issues relating to nuclear materials and nuclear waste programs encompasses all the NRC public health and safety, safeguards, research, operational data analysis and other efforts related to the licensing, inspection, and environmental reviews for non-reactor NRC-regulated activities. The majority of these activities are managed by the Office of Nuclear Material Safety and Safeguards (NMSS). These include oversight of fuel cycle facilities, nuclear materials users, and uranium recovery facilities; the safe management and disposal of low-level and high-level radioactive wastes; the decontamination and decommissioning of facilities and sites associated with NRC-licensed activities; the transportation of nuclear materials; and the safe interim storage of spent fuel.

1.2 Overview of Applicable Rules and Regulations

The NRC protects the public health and safety during civilian uses of nuclear materials through the issuance of performance-based regulations, regulatory guides, generic communications, and NUREGs.

1.2.1 NRC Regulations

The Atomic Energy Act of 1954, as amended, authorizes NRC to develop regulations that licensees must follow to protect health and safety. New or amended regulations are prepared and issued through the rulemaking process, which is managed by the Office of Nuclear Regulatory Research with assistance from other offices such as the Office of the General Counsel, as needed. NRC regulations of interest are found at 10 CFR Chapter I -- Nuclear Regulatory Commission; a partial listing of the most relevant parts includes:

10 CFR 20 - Standards for Protection Against Radiation
10 CFR 30 - Rules of General Applicability to Licensing of the Possession or Use of Nuclear or Byproduct Material in Medicine, Industry (including Low-Level Waste Management at Power Reactors), Agriculture, or Research
10 CFR 35 - Medical Use of Byproduct Material
10 CFR 40 - Domestic Licensing of Nuclear Source Material Facilities
10 CFR 50 - Domestic Licensing of Nuclear Reactors or Fuel Reprocessing Plants
10 CFR 50 Appendix A - "General Design Criteria for Nuclear Power Plants"

10 CFR 50

Appendix I - "Numerical Guides for Design Objectives and Limiting Conditions for Operation Guides to Meet the Criterion as Low as is Reasonably Achievable for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents"

10 CFR 61 - Licensing Requirements for Land Disposal of Radioactive Waste

10 CFR 70 - Domestic Licensing of Special Nuclear Material

10 CFR 71 - Licensing of the Packaging and Transportation of Radioactive material

1.2.2 Regulatory Guides

NRC uses Regulatory Guides to describe acceptable methods of implementing NRC regulations. The guides are issued in ten numbered categories:

1. Power Reactors
2. Research and Test Reactors
3. Fuels and Materials Facilities
4. Environmental and Siting
5. Materials and Plant Siting
6. Products
7. Transportation
8. Occupational Health
9. Antitrust and Financial Review
10. General

Specific Regulatory Guides of interest include:

- Regulatory Guide 1.143 - "Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants," Revision 1, October, 1979.

- Regulatory Guide 8.18 - "Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable," Revision 1, October, 1982.

- Regulatory Guide 10.2 - "Guidance to Academic Institutions Applying for Specific Byproduct Material Licenses of Limited Scope," Revision 1, December, 1976.

- Regulatory Guide 10.4 - "Guide for the Preparation of Applications for Licenses to Process Source Material," Revision 2, December, 1987.

- Regulatory Guide 10.5 - "Applications for Type A Licenses of Broad Scope," Revision 1, December, 1980.

1.2.3 Generic Communications

NRC issues generic communications (bulletins, generic letters, information notices, and administrative letters) to inform groups of licensees about specific problems, developments, or other matters of interest to the licensees. NRC also uses generic letters to request licensees to take specific actions or require them to submit information. Generic communications of interest include:

- IE Circular No. 80-18, "10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems," August, 1980.

- Generic Letter 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites," and Enclosure, "Radiological Safety Guidance for Onsite Contingency Storage Capacity," November 10, 1981

- HPPOS-239, "Clarification of Generic Letter 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites."

- Generic Letter 85-14, "Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility," August 1, 1985.

- Information Notice No. 90-09, "Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Material Licensees," and Attachment, "Information Needed in an Amendment Request to Authorize Extended Interim Storage of Low-Level Radioactive Waste," February 5, 1990.

- Generic Letter 80-051, "Letter to Licensees Concerning On-Site Storage of Low-Level Waste," and Enclosure "Safety Consideration for Temporary On-Site Storage of Low-Level Radioactive Waste," June 9, 1990.

- Policy and Guidance Directive 94-05, "Updated Guidance on Decay-In-Storage," October 19, 1994.

1.2.4 NRC Reports

NRC prepares reports on a wide ranch of topics including:

- Ongoing regulatory proceedings, such as safety evaluation reports and environmental impact statements.

- Technical and regulatory reports of general applicability, such as information supporting regulatory decisions, guidance for meeting NRC regulations, results of task force investigations of specific topics or incidents, analyses of certain regulatory programs, proceedings of conferences and workshops, and administrative information of interest to the staff, the industry, and the public.

- Standard review plans and application guidance to make information about the regulatory licensing process widely available and to improve the understanding of the staff's review process widely available and to improve the understanding of the staff's review process for interested members of the public and the nuclear industry.

These documents are designated as NUREGs and specific NUREG documents of interest include:

- NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR (Light Water Reactor) Edition," July, 1981
  – Section 11.2 - Liquid Waste Management Systems
  – Section 11.3 - Gaseous Waste Management Systems
  – Section 11.4 - Solid Waste Management Systems
  – Appendix 11.4-A - Design Guidance for Temporary Onsite Storage of Low-Level Radioactivity Waste

- NUREG-SR1556, V1, "Consolidated Guidance About Material Licenses: Program-Specific Guidance about Portable Gauge Licenses"

- NUREG-SR1556, V2, "Consolidated Guidance About Material Licenses: Program-Specific Guidance about Industrial Radiography Licenses"

- NUREG-SR1556, V6, "Consolidated Guidance About Material Licenses: Program-Specific Guidance about 10 CFR Part 36 Irradiator Licenses"

- NUREG-SR1556, V7, "Consolidated Guidance About Material Licenses: Program-Specific Guidance about Academic, Research and Development, and other Licenses of Limited Scope"

- NUREG-1600, Rev.1, "General Statement of Policy and Procedures for NRC Enforcement Actions, Enforcement Policy," May, 1998

Other (non-NUREG) documents include the following management directives and inspection manuals:

- Management Directive 8.6 - "Systematic Assessment of Licensee Performance (SALP)
- Inspection Procedure 65051, "Low-Level Radioactive Waste Storage Facilities"
- Inspection Procedure 84101, "Radioactive Waste Management"
- Inspection Procedure 84522, "Solid Wastes (Preoperational and Supplemental)
- Inspection Procedure 84523, "Liquids and Liquid Wastes (Preoperational and Supplemental)
- Inspection Procedure 84524, "Gaseous Waste System (Preoperational and Supplemental)
- Inspection Procedure 84722, "Solid Wastes"
- Inspection Procedure 84723, "Liquids and Liquid Wastes"
- Inspection Procedure 84724, "Gaseous Waste System"

- Inspection Procedure 84750, “Radioactive Waste Treatment, and Effluent and Environmental Monitoring”
- Inspection Procedure 84850, “Radioactive Waste Management - Inspection of Waste Generator Requirements of 10 CFR Part 20 and 10 CFR Part 61"
- Inspection Procedure 84900, “Low-Level Radioactive Waste Storage”
- Inspection Procedure 86750, “Solid Radioactive Waste Management and Transportation of Radioactive Materials”
- Inspection Procedure 87100, “Licensed Materials Programs”
- Inspection Procedure 87110G, “Medical Broad-Scope Inspection Field Notes”
- Inspection Procedure 87110, “Industrial/Academic/Research Programs”
- Inspection Procedure 87110A, “Industrial/Academic/Research Inspection Field Notes”
- Inspection Procedure 88035, “Radioactive Waste Management”

Copies of the Regulatory Guides, Generic Communications, and NRC Reports listed above are provided in Attachment 1 of this background document. Copies the applicable 10 CFR Chapter I regulations (and the above referenced documents) can be obtained either from NRC’s Internet web page at: **http://www.nrc.gov** or the NRC Public Document Room, at 2120 L Street, NW, Lower Level, Washington, DC 20037.

2.0 Nuclear Power Facilities

2.1 Overview of Nuclear Power Facilities Operating in the United States

There are currently 110 commercial nuclear power reactors in the United States, of which 109 are operating in 32 States (one facility is closed and voted to start the decommissioning process in December, 1996). In 1995, the commercial nuclear power industry generated approximately 658.7 thousand gigawatt hours, which was equal to nearly one-fifth of the Nation's electrical output.[4] All nuclear power reactors are licensed directly by the NRC under the authority of the Atomic Energy Act, as amended, and Title 10 of the Code of Federal Regulations.

The U.S. nuclear power industry utilizes two types of light water reactors - the boiling water reactor (BWR) and the pressurized water reactor (PWR). The main component of both reactor designs is the reactor core, in which nuclear fission takes place. The core consists of fuel, which is uranium enriched with an amount of the fissionable isotope U^{235}; coolant, which in light water reactors is ordinary water (rather than heavy water or liquid metal); and a moderator, which reduces the speed of the neutrons released in the fission process. Water is used as a moderator as well as a coolant in light water reactors.

The commercial by-product of the fission process is heat. Power is generated by letting water absorb heat and transfer its potential for work to power turbines. The fission process is carefully managed to control the heat generated by the fuel rods. In addition to water that continually circulates to cool the reactor core, control rods with the capacity to absorb neutrons are used to control the chain reaction.

In light water reactors the heat absorption process can be either direct or indirect. That is, the coolant water can either circulate directly among the fuel rods to absorb heat potential (i.e., direct system) or through piping to a steam generator where another loop of water is heated (i.e., indirect system). The former of these processes is generally known as an “open loop system” and is found in the BWR unit design. The latter process is generally known as a “closed loop system” and is found in the PWR unit design.[5]

Of the two reactor types currently in U.S. commercial application, the BWR unit is the older technology. The BWR unit was directly adapted from military to commercial application; these were some of the first active units in the U.S. during the 1950s. Ordinary water is the primary coolant and power generation medium in these units. There is one self-contained loop for both processes, which is why it is termed an “open loop” system. Water is heated among the core’s fuel rods to the point where steam is generated. The steam is then force-circulated by electrical power pumps into a coolant loop where it is used to drive a turbine that generates electricity. After exiting the turbine, the steam cools further and condenses while being pushed along the

---

[4] U.S. Nuclear Regulatory Commission, “Information Digest,” NUREG-1350, pages 16-30, April, 1997.

[5] Samuel Glasstone and Alexander Sesonske, *Nuclear Reactor Engineering*, Fourth Edition, Volumes 1 and 2, 1994.

back-end of the loop; ultimately, the steam re-enters the core as water where the process is then repeated.

Pressurized water reactors, which constitute a majority (66 percent) of installed units in the U.S., also use water as the primary cooling medium. In contrast to the BWR, water does not circulate through a single loop. Instead, in the PWR unit, water circulates through the reactor core in one self-contained (closed) circulation loop (the primary) to a steam generator. At the steam generator the heat absorbed when circulating through the reactor core is used to vaporize pressurized water in a second closed circulation loop (the secondary). The steam from the second loop is then used to drive a turbine and generate power.

Although there are many similarities, each reactor design can be considered unique as there are:

- 4 reactor vendors
- 48 licensees
- 80 different designs
- 72 sites.

Exhibit 1 identifies the 110 commercial nuclear power reactors constructed in the United States. Exhibit 1 also presents the owning/operating utility, facility location, NRC region, NRC docket number, reactor construction type, and licensed electrical generating capacity by facility.

EXHIBIT 1

SUMMARY OF NUCLEAR POWER REACTORS IN THE UNITED STATES

(from Appendix A, U.S. NRC, "Information Digest," NUREG-1350, 1997)

Unit Name	Operating Utility	City	State	U.S. NRC Docket No.	NRC Region	Construction Type	License MWt
Arkansas Nuc. 1	Entergy Operation, Inc.	Russellville	AR	050-00313	IV	PWR-DRYAMB	2568
Arkansas Nuc. 2	Entergy Operation, Inc.	Russellville	AR	050-00368	IV	PWR-DRYAMB	2815
Beaver Valley 1	Duquesne Light Co.	McCandless	PA	050-00334	I	PWR-DRYSUB	2652
Beaver Valley 2	Duquesne Light Co.	McCandless	PA	050-00412	I	PWR-DRYSUB	2652
Big Rock Point	Consumers Power Co.	Charlevoix	MI	050-00155	III	BWR-DRYAMB	0240
Braidwood 1	Commonwealth Edison Co.	Joilet	IL	050-00456	III	PWR-DRYAMB	3411
Braidwood 2	Commonwealth Edison Co.	Joilet	IL	050-00457	III	PWR-DRYAMB	3411
Browns Ferry 1	Tennessee Valley Authority	Decatur	AL	050-00259	II	BWR-MARK1	3293
Browns Ferry 2	Tennessee Valley Authority	Decatur	AL	050-00260	II	BWR-MARK2	3294
Browns Ferry 3	Tennessee Valley Authority	Decatur	AL	050-00296	II	BWR-MARK3	3295
Brunswick 1	Carolina Power & Light Co.	Southport	NC	050-00325	II	BWR-MARK1	2558
Brunswick 2	Carolina Power & Light Co.	Southport	NC	050-00324	II	BWR-MARK1	2436
Byron 1	Commonwealth Edison Co.	Rockford	IL	050-00454	III	PWR-DRYAMB	3411
Byron 2	Commonwealth Edison Co.	Rockford	IL	050-00455	III	PWR-DRYAMB	3412
Callaway	Union Electric Co.	Fulton	MO	050-00483	IV	PWR-DRYAMB	3565
Calvert Cliffs 1	Baltimore Gas & Electric Co.	Annapolis	MD	050-00317	I	PWR-DRYAMB	2700
Calvert Cliffs 2	Baltimore Gas & Electric Co.	Annapolis	MD	050-00318	I	PWR-DRYAMB	2700
Catawba 1	Duke Power Co.	Rock Hill	SC	050-00413	II	PWR-ICECND	3411
Catawba 2	Duke Power Co.	Rock Hill	SC	050-00414	II	PWR-ICECND	3411
Clinton	Illinois Power Co.	Clinton	IL	050-00461	III	BWR-MARK3	2894
Comanche Peak 1	Texas Utilities Electric Co.	Glen Rose	TX	050-00445	IV	PWR-DRYAMB	3411
Comanche Peak 2	Texas Utilities Electric Co.	Glen Rose	TX	050-00446	IV	PWR-DRYAMB	3411

EXHIBIT 1 (Continued)

Unit Name	Operating Utility	City	State	U.S. NRC Docket No.	NRC Region	Construction Type	License MWt
Cooper	Nebraska Public Power District	Nebraska City	NE	050-00298	IV	BWR-MARK1	2381
Crystal River 3	Florida Power Corp.	Crystal River	FL	050-00302	II	PWR-DRYAMB	2544
D.C. Cook 1	Indiana/Michigan Power Co.	Benton Harbor	MI	050-00315	III	PWR-ICECND	3250
D.C. Cook 2	Indiana/Michigan Power Co.	Benton Harbor	MI	050-00316	III	PWR-ICECND	3411
Davis-Besse	Toledo Edison Co.	Toledo	OH	050-00346	III	PWR-DRYAMB	2772
Diablo Canyon 1	Pacific Gas & Electric Co.	San Luis Obispo	CA	050-00275	IV	PWR-DRYAMB	3338
Diablo Canyon 2	Pacific Gas & Electric Co.	San Luis Obispo	CA	050-00323	IV	PWR-DRYAMB	3411
Dresden 2	Commonwealth Edison Co.	Morris	IL	050-00237	III	BWR-MARK1	2527
Dresden 3	Commonwealth Edison Co.	Morris	IL	050-00249	III	BWR-MARK1	2527
Duane Arnold	IES Utilities, Inc.	Cedar Rapids	IA	050-00331	III	BWR-MARK1	1658
Edwin I. Hatch 1	Southern Nuclear Operating Co.	Baxley	GA	050-00321	II	BWR-MARK1	2558
Edwin I. Hatch 2	Southern Nuclear Operating Co.	Baxley	GA	050-00366	II	BWR-MARK1	2558
Fermi 2	Detroit Edison Co.	Toledo	OH	050-00341	III	BWR-MARK1	3430
Fort Calhoun	Omaha Public Power District	Omaha	NE	050-00285	IV	PWR-DRYAMB	1500
Ginna	Rochester Gas & Electic Corp.	Rochester	NY	050-00244	I	PWR-DRYAMB	1520
Grand Gulf 1	Entergy Operations, Inc.	Vicksburg	MS	050-00416	IV	BWR-MARK3	3833
H.B. Robinson 2	Carolina Power & Light Co.	Florence	SC	050-00261	II	PWR-DRYAMB	2300
Haddam Neck**	CT Yankee Atomic Power Co.	Meriden	CT	050-00213	I	PWR-DRYAMB	1825
Hope Creek 1	Public Service Electic & Gas Co.	Wilmington	DE	050-00354	I	BWR-MARK1	3293
Indian Point 2	Consolidated Edison Co.	New York City	NY	050-00247	I	PWR-DRYAMB	3071
Indian Point 3	Consolidated Edison Co.	New York City	NY	050-00286	I	PWR-DRYAMB	3025
J. A. FitzPatrick	Power Authority of the State of NY	Oswego	NY	050-00333	I	BWR-MARK1	2536
Joseph M. Farley 1	Southern Nuclear Operating Co.	Dothan	AL	050-00348	II	PWR-DRYAMB	2652
Joseph M. Farley 2	Southern Nuclear Operating Co.	Dothan	AL	050-00364	II	PWR-DRYAMB	2652
Kewaunee	Wisconsin Public Service Corp.	Green Bay	WI	050-00305	III	PWR-DRYAMB	0511

EXHIBIT 1 (Continued)

Unit Name	Operating Utility	City	State	U.S. NRC Docket No.	NRC Region	Construction Type	License MWt
La Salle County 1	Commonwealth Edison Co.	Ottawa	IL	050-00373	III	BWR-MARK2	3323
La Salle County 2	Commonwealth Edison Co.	Ottawa	IL	050-00374	III	BWR-MARK2	3323
Limerick 1	Philadelphia Electric Co.	Philadelphia	PA	050-00352	I	BWR-MARK2	3458
Limerick 2	Philadelphia Electric Co.	Philadelphia	PA	050-00353	I	BWR-MARK2	3458
Maine Yankee	Maine Yankee Atomic Power Co.	Bath	NE	050-00309	I	PWR-DRYAMB	2700
McGuire 1	Duke Power Co.	Charlotte	NC	050-00369	II	PWR-ICECND	3411
McGuire 2	Duke Power Co.	Charlotte	NC	050-00370	II	PWR-ICECND	3411
Millstone 1	Northeast Nuclear Energy Co.	New London	CT	050-00245	I	BWR-MARK1	2011
Millstone 2	Northeast Nuclear Energy Co.	New London	CT	050-00336	I	PWR-DRYAMB	2700
Millstone 3	Northeast Nuclear Energy Co.	New London	CT	050-00423	I	PWR-DRYSUB	3411
Monticello	Northern States Power Co.	Minneapolis	MN	050-00263	III	BWR-MARK1	1670
Nine Mile Point 1	Niagra Mohawk Power Corp.	Oswego	NY	050-00220	I	BWR-MARK1	1850
Nine Mile Point 2	Niagra Mohawk Power Corp.	Oswego	NY	050-00410	I	BWR-MARK2	3467
North Anna 1	Virginia Electric & Power Co.	Richmond	VA	050-00338	II	PWR-DRYSUB	2893
North Anna 2	Virginia Electric & Power Co.	Richmond	VA	050-00339	II	PWR-DRYSUB	2893
Oconee 1	Duke Power Co.	Greenville	SC	050-00269	II	PWR-DRYAMB	2568
Oconee 2	Duke Power Co.	Greenville	SC	050-00270	II	PWR-DRYAMB	2568
Oconee 3	Duke Power Co.	Greenville	SC	050-00287	II	PWR-DRYAMB	2568
Oyster Creek	GPU Nuclear Corp.	Toms River	NJ	050-00219	I	BWR-MARK1	1930
Paint Beach 1	Wisconsin Electric Power Co.	Manitowac	WI	050-00266	III	PWR-DRYAMB	1519
Paint Beach 2	Wisconsin Electric Power Co.	Manitowac	WI	050-00301	III	PWR-DRYAMB	1519
Palisades	Consumers Power Co.	South Haven	MI	050-00255	III	PWR-DRYAMB	2530
Palo Verde 1	Arizona Public Service Co.	Phoenix	AZ	050-00528	IV	PWR-DRYAMB	3800
Palo Verde 2	Arizona Public Service Co.	Phoenix	AZ	050-00529	IV	PWR-DRYAMB	3876
Palo Verde 3	Arizona Public Service Co.	Phoenix	AZ	050-00530	IV	PWR-DRYAMB	3876

EXHIBIT 1 (Continued)

Unit Name	Operating Utility	City	State	U.S. NRC Docket No.	NRC Region	Construction Type	License MWt
Peach Bottom 2	PECO Energy Co.	Lancaster	PA	050-00277	I	BWR-MARK1	3458
Peach Bottom 3	PECO Energy Co.	Lancaster	PA	050-00278	I	BWR-MARK1	3458
Perry 1	Cleveland Electic Illuminating Co.	Painsville	OH	050-00440	III	BWR-MARK3	3579
Pilgrim 1	Boston Edison Co.	Plymouth	MA	050-00293	I	BWR-MARK1	1998
Prairie Island 1	Northern States Power Co.	Minneapolis	MN	050-00282	III	PWR-DRYAMB	1650
Prairie Island 2	Northern States Power Co.	Minneapolis	MN	050-00306	III	PWR-DRYAMB	1650
Quad Cities 1	Commonwealth Edison Co.	Moline	IL	050-00254	III	BWR-MARK1	2511
Quad Cities 2	Commonwealth Edison Co.	Moline	IL	050-00265	III	BWR-MARK1	2511
River Bend 1	Entergy Operations, Inc.	Baton Rouge	LA	050-00458	IV	BWR-MARK3	2894
Salem 1	Public Service Electic & Gas Co.	Wilmington	DE	050-00272	I	PWR-DRYAMB	3411
Salem 2	Public Service Electic & Gas Co.	Wilmington	DE	050-00311	I	PWR-DRYAMB	3411
San Onofre 2	Southern CA Edison Co. & San Diego Gas & Electric Co.	San Clemente	CA	050-00361	IV	PWR-DRYAMB	3390
San Onofre 3	Southern California Edison Co. & San Diego Gas & Electric Co.	San Clemente	CA	050-00362	IV	PWR-DRYAMB	3390
Seabrook 1	North Atlantic Energy Service Corp.	Porthsmouth	NH	050-00443	I	PWR-DRYAMB	3411
Sequoyah 1	Tennessee Valley Authority	Chattanooga	TN	050-00327	II	PWR-ICECND	3411
Sequoyah 2	Tennessee Valley Authority	Chattanooga	TN	050-00328	II	PWR-ICECND	3411
Shearon Harris 1	Carolina Power & Light Co.	Raleigh	NC	050-00400	II	PWR-DRYAMB	2775
South Texas Project 1	Houston Lighting & Power Co.	Bay City	TX	050-00498	IV	PWR-DRYAMB	3800
South Texas Project 2	Houston Lighting & Power Co.	Bay City	TX	050-00499	IV	PWR-DRYAMB	3800
St. Lucie 1	Florida Power & Light Co.	Ft. Pierce	FL	050-00335	II	PWR-DRYAMB	2700
St. Lucie 2	Florida Power & Light Co.	Ft. Pierce	FL	050-00389	II	PWR-DRYAMB	2700
Summer	South Carolina Electic & Gas Co.	Columbia	SC	050-00395	II	PWR-DRYAMB	2900
Surry 1	Virginia Electric & Power Co.	Newport News	VA	050-00280	II	PWR-DRYSUB	2546
Surry 2	Virginia Electric & Power Co.	Newport News	VA	050-00281	II	PWR-DRYSUB	2546

EXHIBIT 1 (Continued)

Unit Name	Operating Utility	City	State	U.S. NRC Docket No.	NRC Region	Construction Type	License MWt
Susquehanna 1	Pennsylvania Power & Light Co.	Berwick	PA	050-00387	I	BWR-MARK2	3441
Susquehanna 2	Pennsylvania Power & Light Co.	Berwick	PA	050-00388	I	BWR-MARK2	3441
Three Mile Island 1	GPU Nuclear Corp.	Harrisburg	PA	050-00289	I	PWR-DRYAMB	2568
Turkey Point 3	Florida Power & Light Co.	Miami	FL	050-00250	II	PWR-DRYAMB	2300
Turkey Point 4	Florida Power & Light Co.	Miami	FL	050-00251	II	PWR-DRYAMB	2300
Vermont Yankee	VT Yankee Nuclear Power Corp.	Brattleboro	VT	050-00271	I	BWR-MARK1	1593
Vogtle 1	Southern Nuclear Operating Co.	Augusta	GA	050-00424	II	PWR-DRYAMB	3565
Vogtle 2	Southern Nuclear Operating Co.	Augusta	GA	050-00425	II	PWR-DRYAMB	3565
Washington Nuclear 2	WA Public Power Supply System	Richland	WA	050-00397	IV	BWR-MARK2	3486
Waterford 3	Entergy Operations, Inc.	New Orleans	LA	050-00382	IV	PWR-DRYAMB	3390
Watts Bar 1	Tennessee Valley Authority	Spring City	TN	050-00390	II	PWR-ICECND	3411
Wolf Creek 1	Wolf Creek Nuclear Operating Corp.	Burlington	KS	050-00482	IV	PWR-DRYAMB	3565
Zion 1	Commonwealth Edison Co.	Chicago	IL	050-00295	III	PWR-DRYAMB	3250
Zion 2	Commonwealth Edison Co.	Chicago	IL	050-00304	III	PWR-DRYAMB	3250

Key for Construction Types:

PWR: Pressurized-Water Reactor; BWR: Boiling-Water Reactor; DRYAMB: Dry, Ambient Pressure; DRYSUB: Dry, Subatmospheric; ICECND: Wet, Ice Condenser; MARK 1: Wet, Mark I; MARK 2: Wet, Mark II; MARK 3: Wet, Mark III.

2.2 Waste Generation at Nuclear Power Facilities

The systems used at reactors to control radioactive waste materials differ between PWRs and BWRs, as well as among different vendors. Pressurized water reactors, which must maintain pressure in the primary reactor core cooling water system at up to 2250 pounds per square inch, or 150 times normal atmospheric pressure, use a chemical and volume control system to maintain the proper water volume and to adjust the concentration of boric acid (a neutron moderator) in the system.[6] Water is bled from the primary circuit and is passed through ion-exchange demineralizers and filters. The water then may be returned to the primary circuit. Concentrated boric acid from a boric acid recovery process also may be stored and returned to the primary circuit. "Dirty" waste water, not arising from the primary system but from floor drains and other sources, may contain low levels of radioactivity, so it is generally filtered and evaporated. Used filters, as well as wastes from the demineralizer, must be managed as waste. Finally, tritiated water, formed as a consequence of neutron radiation and the presence of boron in the coolant water, is withdrawn from the primary system, solidified with cement, and disposed in a low-level waste facility.

Pressurized water reactors also use waste treatment systems for gaseous wastes, arising from the primary system, the secondary system, and the reactor building ventilation system. Primary gases in a PWR are generally collected and held in tanks for a substantial period to allow for decay of the radionuclides they contain. Residual gases are then passed through a high-efficiency particulate air filter, mixed with large volumes of filtered ventilation air and discharged. Air filter wastes must be managed.

Boiling water reactors have a single water circulation system, but fission products that escape from the core or are created by activation of materials dissolved or suspended in the coolant water tend to remain in the reactor vessel and recirculating pump system (i.e., in the water side rather than the steam side of the system). Gases tend to pass into the steam and therefore reach the turbines, after which they are separated by a steam-jet air-ejector and passed through a catalytic recombiner and charcoal beds. After the steam has passed through the turbine it goes to condensers. The condensate is passed through a demineralizer before the water is returned to the reactor vessel. Because boron is not used, little tritium is generated. Water from leakage is

---

[6] With respect to PWRs, a handbook on water use in industrial processes states, "High purity must be maintained in the primary loop water to minimize fouling of reactor and exchanger heat transfer surfaces and to avoid contaminants that could from undesirable radioactive isotopes under neutron flux. Controlled additions and removals of boric acid in the primary loop water provide the correct concentration of neutron-absorbing boron needed to control neutron flux and energy transfer. Chemicals such as lithium hydroxide, forming relatively safe radioisotopes under neutron flux, are used for pH control in the primary loop

. . . . Primary loop water purity is usually maintained by continuously passing a portion of the circulating water through a mixed bed demineralizer. These generally utilize anion resins in the borate form, to avoid removal of boron from the water. As impurities accumulate, these resins tend to become radioactive and regeneration becomes impractical. Consequently, the resins are eventually disposed of as a solid radwaste." NALCO Chemical Company, *NALCO Water Handbook*, 2nd Edition, 1988, p. 34.21.

treated by demineralization and filtration. Wastes from ion exchange processes and filters must be managed.

The operation of commercial nuclear power reactors generates various types of radioactive and mixed wastes, including:

- High-Level Radioactive Waste/Spent Fuel
- Transuranic Waste
- Low-Level Radioactive (Non-Mixed and Mixed) Waste.

Although high-level mixed waste and transuranic mixed waste both are generated in large amounts as a result of nuclear fuel production and regeneration activities, they are unlikely to be generated under normal operations at a nuclear reactor.[7] Therefore, the remainder of this section discusses low-level radioactive waste

2.2.1 Low-Level Radioactive Waste

As noted above, reactors operate radioactive waste treatment systems to reduce the radioactivity in their effluents. Low-level radioactive waste generally includes residues from these systems, particularly residues from reactor water treatment systems, as well as other materials that have become contaminated with radioactive material or have become radioactive through exposure to neutron radiation. Such waste can include equipment and tools, protective clothing, filters, cleaning materials, discarded parts, waste oils, and similar materials.

Low-Level Radioactive Waste

Under the Low-Level Radioactive Waste Policy Amendments Act, codified in 42 U.S.C.A §10101, low-level waste is radioactive material that "is not high-level radioactive waste, spent nuclear fuel, transuranic waste, or by-product material as defined in section 2014(e)(2) of this title. . . ." The NRC similarly defines low-level waste in 10 CFR §61.2 as the following:

> "Waste means those low-level radioactive wastes containing source, special nuclear, or byproduct material that are acceptable for disposal in a land disposal facility. For the purposes of this definition, low-level waste has the same meaning as in the Low-Level Waste Policy Act, that is, radioactive waste not classified as high-level radioactive waste, transuranic waste, spent nuclear fuel, or byproduct material as defined in section 11e.(2) of the Atomic Energy Act (uranium or thorium tailings and waste)."

2.2.2 Mixed Radioactive Waste

Mixed waste contains both radioactive waste and hazardous waste. The Electric Power Research Institute (EPRI) has identified 16 processes that may generate low-level mixed

[7] Oak Ridge National Laboratory for the U.S. Nuclear Regulatory Commission, *National Profile on Commercially Generated Low-Level Radioactive Mixed Waste*, NUREG/CR-5938, ORNL-6731, 1992, p. 8 and Electric Power Research Institute, *Nuclear Utility Mixed Waste Stream Characterization Study*, October 1994, p. 1-1. (Henceforth *National Profile* and *Mixed Waste Characterization Study*, respectively.)

waste (LLMW) at commercial nuclear power generators. The potential mixed wastes result from, or can be described generally as, the following:

> **Mixed Radioactive Waste**
>
> RCRA, as amended by the Federal Facility Compliance Act of 1992, defines mixed waste as a waste that contains both hazardous waste and source, special nuclear, or by-product material subject to the Atomic Energy Act (RCRA §1004(41)).

(1) Laboratory analyses performed on radioactive materials such as reactor coolants or lubricating oils. The materials may be a potential LLMW before analysis or the analysis may turn the sample into a LLMW, through the use of hazardous reagents and solvents.

(2) Scintillation fluids used to analyze tritium activity in reactor coolant water.

(3) Solvents used for general radioactive decontamination.

(4) Radioactively contaminated rags used for cleaning equipment, tools, and surfaces that also are contaminated with solvents, paints, or oils.

(5) Mixtures of cleaning solution and radioactive graphite lubricants from cleaning in-core instrumentation packages.

(6) Cleaning solutions and rags used to decontaminate lead radioactive shielding, and discarded lead shielding.

(7) Filters, still bottoms, and spent solvent used in dry cleaning clothing and rags containing radioactive contamination.

(8) Unused paint, brushes, and rags cross-contaminated by radioactivity.

(9) Residues, including used grit and removed material, from dry grit blasting used to remove radioactive contamination from metal equipment and concrete surfaces.

(10) Residues, including carrier liquid, grit and removed material, and filters, from liquid abrasive decontamination of equipment, parts, and tools.

(11) Used oil, oil filters, and associated materials from oil change-out from pumps and other equipment.

(12) Sludge from clean out of tanks and sumps.

(13) Filters, resins, and evaporator bottoms from systems to remove radioactive waste from primary and secondary water systems.

(14) Filters, ion exchange resins, chemicals, and decontamination solutions used to decontaminate piping and components by removing corrosion buildup.

(15) Filters, additives, and spilled material from the use of corrosion inhibitors in the reactor cooling water systems.

(16) Miscellaneous other sources, potentially including filters and ion exchange resins from the reactor core cooling water systems. Although there are no current data to suggest that such filters/resins are mixed waste, there is a possibility of soluble chromium ions being removed by demineralizers for short time periods.[8]

2.3 Applicable Regulations

As briefly discussed in Section 1.2, the construction and operation of nuclear power plants and the subsequent generation and management of radioactive waste is regulated by the NRC, which has issued numerous performance-based regulations, regulatory guides, generic communications, NUREGs, and other documents. The remainder of this section discusses the major components of the regulations and other documents that pertain to the generation and management of radioactive wastes at nuclear power facilities. This discussion also provides the context for how the various regulations and requirements specified in the numerous NRC documents work together to enable the NRC to ensure that nuclear power facilities are operating in a manner that is safe to both human health and the environment.

2.3.1 NRC Regulations

The Atomic Energy Act of 1954, as amended, authorizes NRC to develop regulations that licensees must follow to protect health and safety. NRC regulations of interest are found at 10 CFR Chapter I -- Nuclear Regulatory Commission; a partial listing of the parts most relevant to the construction and operation of nuclear power facilities and the management of radioactive waste includes:

10 CFR 20 - Standards for Protection Against Radiation
10 CFR 50 - Domestic Licensing of Nuclear Reactors or Fuel Reprocessing Plants
10 CFR 50 Appendix A - "General Design Criteria for Nuclear Power Plants"
10 CFR 50 Appendix I - "Numerical Guides for Design Objectives and Limiting Conditions for Operation Guides to Meet the Criterion as Low as is Reasonably Achievable for Radioactive Material in Light-Water-Cooled Nuclear Power Reactor Effluents"
10 CFR 61 - Licensing Requirements for Land Disposal of Radioactive Waste
10 CFR 70 - Domestic Licensing of Special Nuclear Material
10 CFR 71 - Licensing of the Packaging and Transportation of Radioactive material

In general, the management of low-level radioactive waste is subject to a broad range of regulatory provisions. Licensees of nuclear power plants are required by NRC's general radiation protection standards (10 CFR Part 20) to ensure that radioactivity levels released to the

[8] *Mixed Waste Characterization Study*, p. 5-137.

environment are as low as reasonably achievable (ALARA).[9] Portions of 10 CFR Part 20 (Subpart K) also pertain to waste disposal, which is allowed by the NRC only by (1) transfer to an authorized recipient; (2) decay in storage; or (3) release in effluents, but only if within specified dose limits. Authorized recipients of waste, in turn, must be specifically licensed for one or more of the following waste management alternatives:

- Treatment prior to disposal;
- Treatment or disposal by incineration;
- Decay in storage;
- Disposal at a land disposal facility licensed under 10 CFR Part 61; or
- Disposal at a geologic depository licensed under 10 CFR Part 60.

The 10 CFR 50 regulations pertain to the process of obtaining a construction permit; preparing a license application, which also includes the preliminary and final safety analysis reports; and the controlling, monitoring, and reporting of the release of radioactive materials to the environment. Appendix A of Part 50 stipulates the "General Design Criteria for Nuclear Power Plants," which are provided as criteria. The relevant criteria include:

- **Criterion 60** -- *Control of Releases of Radioactive Materials to the Environment*. "The nuclear power unit design shall include means to control suitably the release of radioactive materials in gaseous and liquid effluents and to handle radioactive solid wastes produced during normal reactor operation, including anticipated operational occurrences. Sufficient holdup capacity shall be provided for retention of gaseous and liquid effluents containing radioactive materials, particularly where unfavorable site environmental conditions can be expected to impose unusual operational limitations upon the release of such effluents to the environment."

- **Criterion 61** -- *Fuel Storage and Handling and Radioactivity Control*. "The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions. These systems shall be designed (1) with a capability to permit appropriate periodic inspection and testing of components important to safety, (2) with suitable shielding for radiation protection, (3) with appropriate containment, confinement, and filtering systems, (4) with a residual heat removal capability having reliability and testability that reflects the importance to safety of decay heat and other residual heat removal, and (5) to prevent significant reduction in fuel storage coolant inventory under accident conditions."

- **Criterion 63** -- *Monitoring Fuel and Waste Storage*. "Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions."

---

[9] Waste management is also subject to standards set by EPA under 40 CFR Part 190.

- **Criterion 64** -- *Monitoring Radioactivity Releases*. "Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculating of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents."

The disposal and transportation of radioactive wastes are covered in 10 CFR 61 and 71, respectively. A summary of the relevant regulations is provided below in Exhibit 4.

2.3.2 Regulatory Guides

As noted earlier, NRC uses Regulatory Guides to describe acceptable methods of implementing NRC regulations. The guides are issued in ten numbered categories:

1. Power Reactors
2. Research and Test Reactors
3. Fuels and Materials Facilities
4. Environmental and Siting
5. Materials and Plant Siting
6. Products
7. Transportation
8. Occupational Health
9. Antitrust and Financial Review
10. General

The specific Regulatory Guide of interest for nuclear power facilities is:

- **Regulatory Guide 1.143** - "*Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants*," Revision 1, October, 1979.

NRC prepared this guide to provide information and criteria that will provide reasonable assurance that components and structures used in the radioactive waste management and steam generator blowdown systems are designed, constructed, installed, and tested on a level commensurate with the need to protect the health and safety of the public and plant operating personnel. It also set forth minimum staff recommendations and was not intended to prohibit the implementation of more rigorous design considerations, codes, standards, or quality assurance measures. Relevant sections of the guide include Sections C.1 through C.3, which discuss the minimum design criteria for systems handling radioactive liquids, gases, and solid wastes. A summary of the design requirements are provided in Exhibit 5.

EXHIBIT 4

Summary of 10 CFR Chapter I Regulations Applying to the Generation and Management of Radioactive Wastes at Nuclear Power Facilities

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
	General Requirements	
19.12	Workers should be kept informed of the storage, transfer, or use of radiation and/or of radioactive material. Instructed in the health protection problems associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed.	Training
20.1101(b)	The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).	Secondary Containment, Detection, Monitoring
20.1302	The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public.	Inspection, Monitoring
20.1406	Applicants for licenses, other than renewals, after August 20,1997, shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.	Contamination, Decontamination and Decommissioning, Waste Minimization
20.1801	The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.	Security, Storage
20.1502	Each licensee shall monitor occupational exposure to radiation and shall supply and require the use of individual monitoring devices.	Monitoring
20.1802	The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.	Security, Storage
20.1206	Each licensee shall maintain records of doses received by all individuals for whom monitoring was required, and records of doses received during planned special exposures, accidents, and emergency conditions.	Monitoring, Record Management
20.2202	Immediate notification. Each licensee shall immediately report any event involving byproduct, source, or special nuclear material possessed by the licensee the may have caused or threatens to cause any harm.	Contamination, Emergency Reporting

EXHIBIT 4 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
20.2203	Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards, and associated license conditions.	Corrective Action
20 Appendix G	A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility must prepare a Manifest reflecting information requested on applicable NRC forms 540 and 541, and if necessary, on an applicable NRC form 542. NRC forms 540 and 540A must be completed and must physically accompany the pertinent low-level waste shipment.	Packaging, Shipment, Manifesting
	Nuclear Reactor Requirements	
50.34	Preliminary safety analysis report. Each application for a construction permit shall include a preliminary safety analysis report.	Safety Analysis Report
50.34a	A general description of the provisions for packaging, storage, and shipment offsite of solid waste containing radioactive materials resulting from treatment of gaseous and liquid effluents and from other sources.	Storage, Packaging, Shipment
50.34a	License applicant must include the requirement that each application to construct a nuclear reactor include a preliminary and final safety analysis report.	Application, PSAR, FSAR
50.36a	In order to keep releases of radioactive materials to unrestricted areas during normal conditions, including expected occurrences, as low as is reasonably achievable, each licensee of a nuclear power reactor will include technical specifications that comply with the applicable provisions of 20.1301.	ALARA, Effluents
50.59	(a)(1) The holder of a license authorizing operation of a production or utilization facility may - make changes in the facility as described in the safety analysis report; make changes in the procedures as described in the safety analysis report; and conduct tests or experiments not described in the safety analysis report, without prior Commission approval, unless the proposed change, test or experiment involves a change in the technical specifications incorporated in the license or an unreviewed safety question.	Safety Analysis Report
50 Appendix A	Potential release pathways of all radionuclides present in the solidified waste form shall be monitored. Surveillance programs shall incorporate adequate methods for detecting failure of container integrity and measuring releases to the environment. Monitoring shall be conducted to insure that levels are below limits specified in 10 CFR Part 20. All containers should be decontaminated to these levels.	Inspection, Detection, Containers, Storage, Monitoring

EXHIBIT 4 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
50 Appendix A	Criterion 60 - Control of releases of radioactive materials to the environment requires that radioactive systems be designed to assure adequate safety under normal and postulated accident conditions.	Design Criteria, Secondary Containment
50 Appendix A	Criterion 61 - The fuel storage and handling, radioactive waste, and other systems which may contain radioactivity shall be designed to assure adequate safety under normal and postulated accident conditions.	Design Criteria, Security, Storage
50 Appendix A	Criterion 63 - Monitoring fuel and waste storage. Appropriate systems shall be provided in fuel storage and radioactive waste systems and associated handling areas (1) to detect conditions that may result in loss of residual heat removal capability and excessive radiation levels and (2) to initiate appropriate safety actions.	Monitoring, Storage, Detection
50 Appendix A	Criterion 64 - Monitoring radioactivity releases. Means shall be provided for monitoring the reactor containment atmosphere, spaces containing components for recirculating of loss-of-coolant accident fluids, effluent discharge paths, and the plant environs for radioactivity that may be released from normal operations, including anticipated operational occurrences, and from postulated accidents.	Monitoring, Containers, Containment, LOCA
50 Appendix B- X	A program for inspection of activities affecting quality shall be established and executed by or for the organization performing the activity to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity.	Inspection
50 Appendix B- XIII	Measures shall be established to control the handling, storage, shipping, cleaning and preservation of material and equipment in accordance with work and inspection instructions to prevent damage or deterioration.	Packaging, Storage, Shipment
50 Appendix B- XIV	Measures shall be established to indicate by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the nuclear power plant or fuel reprocessing plant.	Inspection, Records Management
50 Appendix B-XVIII	A comprehensive system of planned and periodic audits shall be carried out to verify compliance with all aspects of the quality assurance program and to determine the effectiveness of the program.	Audits
	Packaging Requirements	

EXHIBIT 4 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
71.43	General standards for all packages. (1) The smallest overall dimension of a package may not be less than 10 cm. (2) The outside of a package must incorporate a feature, such as a seal, that is not readily breakable and that, while intact, would be evidence that the package has not been opened by unauthorized persons. (3) Each package must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package.	Packaging, Storage, Containment
71.43	A package must be made of materials and construction that assure that there will be no significant chemical, galvanic, or other reaction among the packaging components, among package contents, or between the packaging components and the package contents, including possible reaction resulting from leakage of water, to the maximum credible extent. Account must be taken of the behavior of materials under irradiation	Packaging, Storage
71.43	A package valve or other device, the failure of which would allow radioactive contents to escape, must be protected against unauthorized operation and, except for a pressure relief device, must be provided with an enclosure to retain any leakage.	Packaging, Containment
71.43	A package must be designed, constructed, and prepared for shipment so that under tests there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging.	Packaging, Storage, Containment
71.43	A package may not incorporate a feature intended to allow continuous venting during transport.	Packaging, Containment, Storage
71.45	Any lifting attachment that is a structural part of a package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting device under excessive load would not impair the ability of the package to meet other requirements of this subpart.	Packaging, Containment
71.73	Test procedures. Evaluation for hypothetical accident conditions is to be based on sequential application of the tests specified in this section, in the order indicated, to determine their cumulative effect on a package or array of packages.	Packaging, Containers, Inspection, Testing
71.107	The licensee shall establish measures to assure that applicable regulatory requirements and the package design, as specified in the license for those materials and components to which this section applies, are correctly translated into specifications, drawings, procedures, and instructions.	Packaging, Containers, Records Management

EXHIBIT 4 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
71.121	The licensee shall establish and execute a program for inspection of activities affecting quality by or for the organization performing the activity, to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity.	Packaging, Containers, Inspection
71.125	The licensee shall establish measures to assure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified times to maintain accuracy within necessary limits.	Packaging, Containers, Maintenance Procedures
71.127	The licensee shall establish measures to control, in accordance with instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration.	Packaging, Storage, Shipping Procedures
71.129	The licensee shall establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging.	Packaging, Containers, Labeling Procedures
71.133	The licensee shall establish measures to assure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformance, are promptly identified and corrected.	Packaging, Procedures, Conditions Adverse to Quality, Corrective Action
71.137	The licensee shall carry out a comprehensive system of planned and periodic audits, to verify compliance with all aspects of the quality assurance program, and to determine the effectiveness of the program.	Audits, Quality Assurance Program

EXHIBIT 5

Summary of Design Requirements Stipulated in Regulatory Guide 1.143

Regulatory Position No.	Minimum Design Criteria
Liquids	
1.1	The liquid radwaste treatment system, including the steam generator, blowdown system, downstream of the outermost containment isolation valve should meet the following criteria:
1.1.1	The systems should be designed and tested to requirements set forth in the codes and standards listed in Table 1 supplemented by regulatory positions 1.1.2 and 4 of this guide.
1.1.2	Materials for pressure-retaining components should conform to the requirements of the specifications for materials listed in Section II of the ASME Boiler and Pressure Vessel Code, except that malleable, wrought, or cast iron materials and plastic pipe should not be used. Materials should be compatible with the chemical, physical, and radioactive environment of specific applications during normal conditions and anticipated operational occurrences. Manufacturer's material certificates of compliance in the codes referenced in Table 1 may be provided in lieu of certified material test reports.
1.1.3	Foundations and walls of structures that house the liquid radwaste system should be designed to the seismic criteria described in regulatory position 5 of this guide to a height sufficient to contain the maximum liquid inventory expected to be in the building.
1.1.4	Equipment and components used to collect, process, and store liquid radioactive waste need not be designed to the seismic criteria given in regulatory position 5 of this guide.
1.2	All tanks located outside reactor containment and containing radioactive materials in liquids should be designed to prevent uncontrolled releases of radioactive materials due to spillage in buildings or from outdoor tanks. The following design features should be included for such tanks:
1.2.1	All tanks inside and outside the plant, including the condensate storage tanks, should have provisions to monitor liquid levels. Designated high-liquid-level conditions should actuate alarms both locally and in the control room.
1.2.2	All tank overflows, drains, and sample lines should be routed to the liquid radwaste treatment system.
1.2.3	Indoor tanks should have curbs or elevated thresholds with floor drains routed to the liquid radwaste treatment system.
1.2.4	The design should include provisions to prevent leakage from entering unmonitored and nonradioactive systems and ductwork in the area.
1.2.5	Outdoor tanks should have a dike or retention pond capable of preventing runoff in the event of a tank overflow and should have provisions for sampling collected liquids and routing them to the liquid radwaste treatment systems.

EXHIBIT 5 (Continued)

Regulatory Position No.	Minimum Design Criteria
Gases	
2.1	The gaseous radwaste treatment system should meet the following criteria:
2.1.1	Materials for pressure-retaining components should conform to the requirements of the specifications for materials listed in Section II of the ASME Boiler and Pressure Vessel Code, except that malleable, wrought, or cast iron materials and plastic pipe should not be used. Materials should be compatible with the chemical, physical, and radioactive environment of specific applications during normal conditions and anticipated operational occurrences. If the potential for an explosive mixture of hydrogen and oxygen exists, adequate provisions should be made to preclude buildup of explosive mixtures, or the system should be designed to withstand the effects of an explosion. Manufacturer's material certificates of compliance in the codes referenced in Table 1 may be provided in lieu of certified material test reports.
2.1.3	Those portions of the gaseous radwaste treatment system that are intended to store or delay the release of gaseous radioactive waste, including portions of structures housing these systems, should be designed to the seismic design criteria given in regulatory position 5 of this guide. For the systems that normally operate at pressures above 1.5 atmospheres, these criteria should apply to isolation valves, equipment, interconnecting piping, and components located between the upstream and downstream valves used to isolate these components from the rest of the system (e.g., waste gas storage tanks in the PWR) and to the building housing this equipment. For systems that operate near ambient pressure and retain gases on charcoal adsorbers, these criteria should apply to the tank supporting elements (e.g., charcoal delay tanks in a BWR) and the building housing the tanks.
Solids	
3.1	The solid radwaste system consists of slurry waste collection and settling tanks, spent resin storage tanks, phase separators, and components and subsystems used to solidify radwastes prior to offsite shipment. The solid radwaste handling and treatment system should meet the following criteria:
3.1.1	The system should be designed and tested to the requirements set forth in the codes and standards listed in Table 1 supplemented by regulatory positions 3.1.2 and 4 of this guide.
3.1.2	Materials for pressure-retaining components should conform to the requirements of the specifications for materials listed in Section II of the ASME Boiler and Pressure Vessel Code, except that malleable, wrought, or cast iron materials and plastic pipe should not be used. Materials should be compatible with the chemical, physical, and radioactive environment of specific applications during normal conditions and anticipated operational occurrences. Manufacturer's material certificates of compliance in the codes referenced in Table 1 may be provided in lieu of certified material test reports.
3.1.3	Foundations and walls of structures that house the solid radwaste system should be designed to the seismic criteria described in regulatory position 5 of this guide to a height sufficient to contain the maximum liquid inventory expected to be in the building.
3.1.4	Equipment and components used to collect, process, or store solid radwastes need not be designed to the seismic criteria in regulatory position 5 of this guide.
Additional Design, Construction, and Testing Criteria	

EXHIBIT 5 (Continued)

Regulatory Position No.	Minimum Design Criteria
4.1	Radioactive waste management structures, systems, and components should be designed to control leakage and facilitate access, operation, inspection, testing, and maintenance in order to maintain radiation exposures to operating and maintenance personnel as low as is reasonably achievable.

2.3.3 Generic Communications

NRC issues generic communications (bulletins, generic letters, information notices, and administrative letters) to inform groups of licensees about specific problems, developments, or other matters of interest to the licensees. NRC also uses generic letters to request licensees to take specific actions or require them to submit information. Generic communications of interest to nuclear power facilities concerning the management of radioactive wastes include:

- **IE Circular No. 80-18**, *"10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems,"* August, 1980. In this document, NRC discusses changes to radwaste systems and clarified the requirements of 10 CFR 50.59, which is composed of three essential parts.

  "First, paragraph (a)(1) is permissive in that it allows the licensee to make changes to the facility and its operation as described in the Safety Analysis Report without prior approval, provided that a change in Technical Specifications is not involved or an "unreviewed safety question" does not exist. Criteria for determining whether an "unreviewed safety question" exists are defined in paragraph (a)(2). Second, paragraph (b) requires that records of changes made under the authority of paragraph (a)(1) be maintained. These records are required to include a written safety evaluation that provides the basis for determining whether an "unreviewed safety question" exists. Paragraph (b) also requires a report (at least annually) of such changes to the NRC. Third, paragraph (c) requires that proposed changes in Technical Specifications be submitted to the NRC as an application for license amendment. Likewise, proposed changes to the facility or procedures and the proposed conduct of tests that involve an "unreviewed safety question" are required to be submitted to the NRC as an application for license amendment.

  Any proposed change to a system or procedures described in the SAR, either by text or drawings, should be reviewed by the licensee to determine whether it involves an "unreviewed safety question." Maintenance activities that do not result in a change to a system (permanent or temporary), or that replace components with replacement parts procured with the same (or equivalent) purchase specification, do not require a written safety evaluation to meet the 10 CFR 50.59 requirements. However, a safety evaluation is required to meet the provisions of 10 CFR 50.59 and any change must be reported to the NRC as required by 10 CFR 50.59(b) if the following circumstances occur: (1) components described in the SAR are removed; (2) component functions are altered; (3) substitute components are utilized; or (4) changes remain following completion of a maintenance activity."

- **Generic Letter 81-38**, *"Storage of Low-Level Radioactive Wastes at Power Reactor Sites," and Enclosure, "Radiological Safety Guidance for Onsite Contingency Storage Capacity,"* November 10, 1981. In this generic letter, NRC discusses its position on proposed increases in storage capacity for low-level wastes generated by normal reactor operation and maintenance and stated that the safety of the proposal must be evaluated by the licensee under the provisions of 10 CFR 50.59. Specifically, NRC stated that "If (1) your existing license conditions or technical specifications do not prohibit increased storage, (2) no unreviewed safety question exists, and (3) the proposed increased storage capacity does not exceed the generated waste projected for five years, the licensee may provide the added capacity, document the 50.59 evaluation and report it to the Commission annually or as specified in the license."

  The NRC also attached a radiological safety guide to this letter. This guide was developed for the design and operation of interim contingency low-level waste storage facilities, and that necessary design features and administrative controls would be dictated by such factors as the waste form, concentrations of radioactive material in individual waste containers, total amount of radioactivity to be stored, and retrievability of waste. Lastly, NRC noted that this guidance document should be used in the design, construction and operation of storage facilities and that the NRC would judge the adequacy of 10 CFR Part 50.59 evaluations based on compliance with the guidance. (NRC also referenced IE Circular No. 80-19, dated August 22, 1980, as providing information on preparing 50.59 evaluations for changes to radioactive waste treatment systems).

  Excerpts of this guidance manual that accompanied this generic letter are provided in Exhibit 6.

- **HPPOS-239**, *"Clarification of Generic Letter 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites."* In this document, NRC clarified that "Generic letter 81-38 can not be used as a basis for citing licensees for storing their normally generated low-level radioactive waste past a defined time period (e.g., 5 years). However, storage of such waste beyond the period allowed by the license (if specified) or referenced in the FSAR, without amending the license or performing a 10 CFR 50.59 evaluation and submitting an updated FSAR in accordance with 10 CFR 50.71(e), may be a basis for enforcement action."

EXHIBIT 6

NRC's Guidance for Onsite Contingency Storage Capacity

II. General Information

- Prior to any implementation of additional on-site storage, substantial safety review and environmental assessments should be conducted to assure adequate public health and safety and minimal environmental impact. The acceptance criteria and performance objectives of any proposed storage facility, or area, will need to meet minimal requirements in areas of design, operations, safety considerations and policy considerations. For purposes of this technical position, the major emphasis will be on safety considerations in the storing, handling and eventual disposition of the radioactive waste. Design and operational acceptability will be based on minimal requirements which are defined in existing SRPs, Regulatory Guides, and industry standards for proper management of radioactive waste. Considerations for waste minimization and volume reduction will also have to be incorporated into an overall site waste management plan and the on-site storage alternative. Additional waste management considerations for ALARA, decontamination, and decommissioning of the temporary storage facility, including disposal, should be performed as early as possible because future requirements for waste forms may make stored wastes unacceptable for final disposition.

- Facility design and operation should assure that radiological consequences of design basis events (fire, tornado, seismic event, flood) should not exceed a small fraction (10%) of 10 CFR Part 100, i.e., no more than a few rem whole body dose.

- The added capacity would typically extend storage to accommodate no more than an amount of waste generated during a nominal five-year period. In addition, waste should not be stored for a duration that exceeds five-years. Storage of waste in excess of the quantities and duration described herein requires Part 30 licensing approval. The design capacity (ft3, C1) should be determined from historical waste generation rates for the station, considering both volume minimization/reduction programs and the need for surge capacity due to operations which may generate unusually large amounts of waste.

- The five-year period is sufficient to allow licensees to design and construct additional volume reduction facilities (incinerators, etc.), as necessary, and than process wastes that may have been stored during construction. Regional state compacts to create additional low-level waste disposal site should also be established within the next five years.

III. Generally Applicable Guidance

(a) The quantity of radioactive material allowed and the shielding configurations will be dictated by the dose rate criteria for both the site boundary and unrestricted areas on site. The 40 CFR 190 limits will restrict the annual dose from direct radiation and effluent releases from all sources of uranium fuel cycle and 10 CFR Part 20.105 limits the exposure rates in unrestricted areas. Offsite does from on-site storage must be sufficiently low to account for other uranium fuel cycle sources (e.g., an additional dose of 1 mrem/year is not likely to cause the limits of 40 CFR 190 to be exceeded). On-site dose limits associated with temporary storage will be controlled per 10 CFR Part 20 including the ALARA principal of 10 CFR 20.1.

EXHIBIT 6 (Continued)

(b) Compatibility of the container materials with the waste forms and with environmental conditions external to the containers is necessary to prevent significant container corrosion. Container selection should be based on data which demonstrates minimal corrosion from the anticipated internal and external environment for a period well in excess of the planned storage duration. Container integrity after the period of storage should be sufficient to allow handling during transportation and disposal without container breach.

Gas generation from organic materials in waste containers can also lead to container breach and potentially flammable/explosive conditions. To minimize the number of potential problems, the waste from gas generation rates from radiolysis, biodegradation, or chemical reaction should be evaluated with respect to container breach and the creation of flammable/explosive conditions. Unless storage containers are equipped with special vent designs which allow depressurization and do not permit the migration of radioactive materials, resins highly loaded with radioactive material, such as BWR reactor water cleanup system resins, should not be stored for a period in excess of approximately one year.

A program of at least periodic (quarterly) visual inspection of container integrity (swelling, corrosion products, breach) should be performed. Inspection can be accomplished by use of TV monitors; by walk-throughs if storage facility layout, shielding, and the container storage array permit; or by selecting waste and containers stored in the facility and placing them in a location specifically designed for inspection purposes. All inspection procedures developed should minimize occupational exposure. The use of high integrity containers (300 year lifetime design) would permit an inspection program of reduced scope.

(c) If possible, the preferred location of the additional storage facility is inside the plant protected area. If adequate space in the protected area is not available, the storage facility should be placed on the plant site and both a physical security program (fence, locked and alarmed gates/doors, periodic patrols) and a restricted area for radiation protection purposes should be established. The facility should not be placed in a location that requires transportation of the waste over public roads unless no other feasible alternatives exist. Any transportation over public roads must be conducted in accordance with NRC and DOT regulations.

(d) For low level dry waste and solidified waste storage:

1. Potential release pathways of all radionuclides present in the solidified waste form shall be monitored as per 10 CFR 50, Appendix A. Surveillance programs shall incorporate adequate methods for detecting failure of container integrity and measuring releases to the environment. For outside storage, periodic direct radiation and surface contamination monitoring shall be conducted to insure that levels are below limits specified in 10 CFR 20.202, 20.205, and 49 CFR 173.397. All containers should be decontaminated to these levels or below before storage.

2. Provisions should be incorporated for collecting liquid drainage including provisions for sampling all collected liquids. Routing of the collected liquids should be to radwaste systems if contamination is detected or to normal discharge pathways if the water ingress is from external sources and remains uncontaminated.

EXHIBIT 6 (Continued)

3. Waste stored in outside areas should be held securely by installed hold down systems. The hold down system should secure all containers during severe environmental conditions up to and including the design basis event for this waste storage facility.

4. Container integrity should be assured against corrosion from the external environment; external weather protection should be included where necessary and practical. Storage containers should be raised off storage pads where water accumulation can be expected to cause external corrosion and possible degradation of container integrity.

5. Total curie limits should be established based on the design of the storage area and the safety measures provided.

6. Inventory records of waste types, contents, dates of storage, shipment, etc., should be maintained.

IV. Wet Radioactive Waste Storage

(a) Wet radioactive waste will be defined as any liquid or liquid/solid slurry. For storage considerations, wet waste is further defined as any waste which contains free liquid in amounts which exceed the requirements for burial as established by the burial ground licensing authority.

(b) The facility supporting structure and tanks should be designed to prevent uncontrolled releases of radioactive materials due to spillage or accident conditions.

(c) The following design objectives and criteria are applicable for wet radioactive waste storage facilities:

1. Structures that house liquid radwaste storage tanks should be designed to seismic criteria as defined in Standard Review Plant (Section 11.2). Foundations and walls shall also be designed and fabricated to contain the liquid inventory which might be released during a container/tank failure.

2. All tanks or containers should be designed to withstand the corrosive nature of the wet waste stored. The duration of storage under which the corrosive conditions exist shall also be considered in the design.

3. All storage structures should have curbs or elevated thresholds with floor drains and sumps to safely collect wet waste assuming the failure of all tanks or containers. Provisions should be incorporated to remove spilled wet waste to the radwaste treatment systems.

4. All tanks and containers shall have provisions to monitor liquid levels and to alarm potential overflow conditions.

EXHIBIT 6 (Continued)

5. All potential release pathways of radionuclides (e.g., evolved gases, breach of container, etc.) shall be controlled, if feasible, and monitored as per 10 CFR 50, Appendix A (General Design Criteria 60 and 4). Surveillance programs should incorporate adequate methods for monitoring breach of container integrity or accidental releases.

6. All temporarily stored wet waste will require additional reprocessing prior to shipment offsite; therefore, provisions should be established to integrate the required treatment with the waste processing and solidification systems. The interface and associated systems should be designed and tested in accordance with the codes and standards described in Standard Review Plan Section 11.

V. Solidified Radioactive Waste Storage

(a) Solidified radwaste for storage purposes shall be defined as that waste which meets burial site solidified waste criteria. For purposes of this document, resins or filter sludges dewatered to the above criteria will be defined under this waste classification/criteria.

(b) Any storage plans should address container protection as well as any reprocessing requirements for eventual shipment and burial.

(c) Casks, tanks, and liners containing solidified radioactive waste should be designed with good engineering judgment to preclude or reduce the probability of occurrence of uncontrolled releases of radioactive materials due to handling, transportation or storage. Accident mitigation and control for design basis events (e.g., fire, flooding, tornadoes, etc.) must be evaluated and protected against unless otherwise justified.

(d) The following design objectives and criteria are applicable for solidified waste storage containers and facilities:

1. All solidified radwaste should be located in restricted areas where effective material control and accountability can be maintained. While structures are not required to meet seismic criteria, protection should be afforded to insure the radioactivity is contained safely by use of good engineering judgment, such as the use of curbs and drains to contain spills of dewatered resins or sludges.

2. If liquids exist which are corrosive, proven provisions should be made to protect the container (i.e., special liners or coatings) and/or neutralize the excess liquids. If deemed appropriate and necessary, highly non-corrosive materials (e.g., stainless steel) should be used. Potential corrosion between the solid waste forms and the container should also be considered. In the case of dewatered resins, highly corrosive acids and bases can be generated which will significantly reduce the longevity of the container. The Process Control Program (PCP) should implement steps to assure the above does not occur; provisions on container material selection and precoating should be made to insure that container breach does not occur during temporary storage periods.

EXHIBIT 6 (Continued)

3. Provision should be made for additional reprocessing or repackaging due to container failure and/or, as required for final transporting and burial as per DOT and burial site criteria. Contamination isolation and decontamination capabilities should be developed. When significant handling and personnel exposure can be anticipated, ALARA methodology should be incorporated as per Regulatory Guides 8.8 and 8.10.

4. Procedures should be developed and implemented for early detection, prevention and mitigation of accidents (e.g., fires). Storage areas and facility designs should incorporate good engineering features and capabilities for contingencies so as to handle accidents and provide safeguard systems such as fire detectors and suppression systems, (e.g., smoke detector and sprinklers). Personnel training and administrative procedures should be established to insure both control of radioactive materials and minimum personnel exposures. Fire suppression devices may not be necessary if combustible materials are minimal in the area.

VI. Low Level Dry Waste Storage

(a) Low level dry waste is classified as contaminated material (e.g., paper, trash, air filters) which contains radioactive material dispersed in small concentrations throughout large volumes of inert material and contains no free water. Generally, this consists of dry material such as rags, clothing, paper and small equipment (i.e., tools and instruments) which cannot be easily decontaminated.

(b) Licensees should implement controls to segregate and minimize the generation of low level dry waste to lessen the impact on waste storage. Integration of Volume Reduction (VR) hardware should be considered to minimize the need for additional waste storage facilities.

(c) The following design objectives and criteria are applicable for low level dry waste storage containers and facilities.

1. All dry or compacted radwaste should be located in restricted areas where effective material control and accountability can be maintained. While structures are not required to meet seismic criteria, protection should be afforded to insure the radioactivity is contained safely by use of good engineering judgment.

2. The waste container should be designed to insure radioactive material containment during normal and abnormal occurrences. The waste container materials should not support combustion. The packaged material should not cause fires through spontaneous chemical reactions, retained heat, etc.

3. Containers should generally comply with the criteria of 10 CFR 71 and 49 CFR 170 to minimize the need for repackaging for shipment.

4. Increased container handling and personnel exposure can be anticipated, consequently, all ALARA methodology should be incorporated per Regulatory Guides 8.8 and 8.10.

- **Generic Letter 85-14**, *"Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility,"* August 1, 1985. NRC, in this letter, stated that:

> "While some licensees have taken steps to temporarily store LLW generated, at their sites to alleviate any impact that limiting of access to disposal capacity may have on licensed operations, provisions for storing LLW should be used only for interim contingency purposes. It is the policy of the NRC that licensees should continue to ship waste for disposal at existing sites to the maximum extent practicable.
>
> In anticipation of possible curtailment of access to existing disposal facilities, interest is being expressed in some states in commercial storage of LLW generated within the states. While the NRC recognizes that storage may appear desirable in states which have not resolved their low-level waste disposal problems, commercial storage facilities, however, should not become de facto disposal sites. NRC will require for commercial storage under its jurisdiction that, in addition to safe siting and operation, commitments and assurances be made for eventual disposition of all waste stored at commercial storage locations. This includes provisions for repackaging (if necessary), transportation and disposal of the waste, as well as decommissioning of the facilities.
>
> Some of the concepts for commercial storage involve using nuclear power reactor sites as commercial storage locations for LLW not generated by the utility licensee. As a matter of policy, the NRC is opposed to any activity at a nuclear reactor site which is not generally supportive of activities authorized by the operating license or construction permit and which may divert the attention of licensee management from its primary task of safe operation or construction of the power reactor. Accordingly, interim storage of LLW within the exclusion area of a reactor site, as defined in 10 CFR 100.3(a), will be subject to NRC jurisdiction regardless of whether or not the reactor is located in an Agreement State, pursuant to the regulatory policy expressed in 10 CFR 150.15(a)(l). Within Agreement States, for locations outside the exclusion areas, the licensing authority is in the Agreement State.
>
> In order for NRC to consider any proposal for commercial storage at a reactor site, including commercial storage in existing low-level waste storage facilities, the NRC must be convinced that no significant environmental impact will result and that the commercial storage activities will be consistent with and not compromise safe operation of the licensee's activities, including diverting reactor management attention from the continued safety of reactor operations. A Part 30 license is required for the low-level waste storage and a Part 50 license amendment may also be required...."

- **Generic Letter 80-051**, *"Letter to Licensees Concerning On-Site Storage of Low-Level Waste,"* and Enclosure *"Safety Consideration for Temporary On-Site Storage of Low-Level Radioactive Waste,"* June 9, 1990. In this generic letter, NRC stated that:

  > "If on-site storage is necessary, the Licensee must assure that the design and operation of the proposed facilities are adequate to maintain public health and safety, minimal risk to operating personnel, and present a minimal environmental impact.
  >
  > Any decision to incorporate on-site storage requires a 10 CFR 50.59 safety review of the areas of (1) Radioactive Material and Effluent Control, (2) Radiation Dose Control for both on-site and off-site individuals, and (3) for "Safety Considerations for Temporary On-Site Storage."...

  NRC's enclosure, "Safety Consideration for Temporary On-Site Storage of Low-Level Radioactive Waste," which was modeled after NRC's previous guidance, entitled *Radiological Safety Guidance for Onsite Contingency Storage Capacity,*" (presented in Generic Letter 81-38), stated that the duration of temporary material storage is to be up to four years and addressed the storage of wet waste, solidified wet waste, and dry low-level radioactive waste. Excerpts of this document are provided in Exhibit 7.

2.3.4 NRC Reports

As briefly discussed above, NRC prepares reports on a wide ranch of topics including:

- Ongoing regulatory proceedings, such as safety evaluation reports and environmental impact statements.

- Technical and regulatory reports of general applicability, such as information supporting regulatory decisions, guidance for meeting NRC regulations, results of task force investigations of specific topics or incidents, analyses of certain regulatory programs, proceedings of conferences and workshops, and administrative information of interest to the staff, the industry, and the public.

- Standard review plans and application guidance to make information about the regulatory licensing process widely available and to improve the understanding of the staff's review process widely available and to improve the understanding of the staff's review process for interested members of the public and the nuclear industry.

EXHIBIT 7

NRC's Safety Consideration for Temporary On-Site Storage of LLW

II. General Information

- Prior to any implementation of additional on-site storage, substantial safety reviews and environmental analysis need to be conducted to assure adequate public health and safety, and minimal environmental impact. The acceptance criteria and performance objectives of any proposed storage facility, or area, will need to meet minimal requirements in areas of design considerations operational considerations, safety considerations and policy considerations.

- For purposes of this branch position, the major emphasis will be on safety considerations in the storing, handling and eventual disposition of the radioactive waste. Design and operational acceptability will be based on minimal requirements which are defined in existing SRP's, Regulatory Guides, and industry standards for proper management of radioactive waste. Policy considerations for waste minimization and volume reduction will also have to be integrated into the waste management plan and the on-site storage alternative.

- Additional considerations for ALARA, decontamination, and decommissioning of the temporary storage facility also need to be integrated into the design and operation of the proposed waste storage facility. Integration of waste volume reduction and eventual disposal should be performed as early as possible because future requirements for waste forms may make stored wastes unacceptable for final disposition.

III. Wet Radioactive Waste Storage

(a) Wet radioactive waste will be defined as any liquid or liquid/solid slurry. For storage considerations, wet waste is further defined as any waste which does not meet January 1, 1981 burial requirements for solidified waste (i.e, < 0.5% free water by volume of container or < 1.0 gallon per container whichever is less).

(b) The facility, supporting structure and tanks should be designed to prevent uncontrolled releases of radioactive materials due to spillage or accident conditions.

(c) The following design objectives and criteria are applicable for wet radioactive waste facilities.

(1) Structures that house liquid radwaste storage tanks should be designed to seismic criteria as defined in Standard Review Plan (NUREG 75087) - Section 11.2). Foundations and walls shall also be designed and fabricated to contain the liquid inventory which might be released during a container/tank failure.

(2) All tanks or containers should be designed to withstand the corrosive nature of the wet waste stored. The duration of storage under which the corrosive conditions exist shall also be considered in the design.

EXHIBIT 7 (Continued)

(3) All storage structures should have curbs or elevated thresholds with floor drains and sumps to safely collect wet waste assuming the failure of all tanks or containers. Provisions should be incorporated to route spilled wet waste to the radwaste treatment systems.

(4) All tanks and containers shall have provisions to monitor liquid levels and to alarm potential overflow conditions.

(5) The quantity of radioactive material allowed and the shielding configurations will be dictated by the dose rate criteria for both the site boundary and unrestricted areas on-site. The 40 CFR 190 limits will restrict the annual dose from direct radiation and effluent release to the Public (individual) to less than 25 mrem per year to the whole body from all sources of the Uranium fuel cycle; therefore, off-site doses from on-site storage must be sufficiently low to account for other sources (e.g., < 1 mrem/year). On-site dose limits associated with temporary storage will controlled per 10 CFR Part 20 including the ALARA principle of 10 CFR 20.1.

(6) All potential release pathways of radionuclides (e.g., evolved gases breach of container, etc.) shall be controlled and, monitored as per 10 CFR 50 Appendix A (General Design Criteria 60 and 64). Surveillance programs should incorporate adequate methods for monitoring breach of container integrity or accidental releases.

(7) All temporarily stored wet waste will require additional reprocessing prior to shipment off-site; therefore, provision should be established to integrate the required treatment with the waste processing and solidification systems. The interface and associated systems should be designed and tested in accordance with the codes and standards described in NUREG-75/087 Section 11

IV. Solidified Radioactive Waste Storage

(a) Solidified radwaste for storage purposes shall be defined as that waste which meets January 1, 1981 burial site solidified waste criteria. Therefore, solidified radwaste will be identified as wet waste (e.g., evaporation bottoms, resins, and sludge) which is solidified and contains < 0.5% free water (by container volume) or 1.0 gallon of liquid (in the container), whichever is less. For purposes of this document resins or filter sludges dewatered to the above criteria will be defined under this waste classification/criteria.

(b) Dewatered resins and filter media with radioactivity levels above 1 uCi/cc (>5 yr, half-life) which are disposed of a after July 19, 1981, will be required to be solidified or stored in high integrity containers (e.g. reinforced concrete). Any storage plans, should address container protection as well as reprocessing requirements for eventual shipment & burial.

(c) Cask, tanks, and liners containing solidified radioactive waste should be designed with good engineering judgment to preclude or reduce the occurrence of uncontrolled releases of radioactive materials due to handling, transporting or storage. Accident mitigation and control for design basis events (e.g., fire, flooding, tornadoes, etc.) must be evaluated and protected against unless otherwise justified.

(d) The following objectives and criteria are applicable for solidified waste storage containers and facilities:

(1) All solidified radwaste should be located in restricted areas where effective material control accountability can be maintained. While structures are not required to meet seismic criteria, protection should be afforded to insure the radioactivity is contained safely by use good engineering judgment, such as the use of curbs and drains to contain spills of dewatered resins or sludges.

(2) Container material selection should conform to requirements established in NUREG-75/087 (Section 11). If liquids exist which are corrosive, proven provisions should be made to protect the container (i.e., special liners or coatings) and, or neutralize the excess liquids. If deemed appropriate and necessary, highly non-corrosive materials (e.g., stainless steel) should be use. Potential corrosion between the solid waste forms and the container should also be considered. In the case of dewatered resins, highly corrosive acids and bases can be generated which will significantly reduce the longevity of the container. The Process Control Program (PCP), should implement steps to assure the above does not occur, and provisions on container material selection and precoating should implement steps to assure the above does not occur, and provisions on container material selection and precoating should be made to insure that container breach does not occur during temporary storage periods.

(3) Potential release pathways of all radionuclides present in the solidified waste form shall be monitored as per 10 CFR 50 Appendix A. Surveillance programs shall incorporate adequate methods for detecting failure or container integrity and measuring releases to the environment. For outside storage, periodic direct radiation and surface contamination monitoring shall be conducted to insure that levels are below limits specified in 10 CFR 20.202, 20.205, and 49 CFR 173.397. All containers should be decontaminated to these levels or below before storage.

(4) Provision should be made for additional reprocessing or repackaging due to container failure and/or, as required for final transportation and burial as per DOT and burial site criteria. Contamination isolation and decontamination capabilities should be developed. Whereby significant handling personnel exposure can be anticipated, ALARA method should be incorporated as per Regulatory Guides 3.8 and 8.10.

(5) Procedures should be developed and implemented for early detection, prevention and mitigation of accidents (e.g., fires). Storage areas and facility designs should incorporate good engineering features and contingencies so as to handle accidents and provide

EXHIBIT 7 (Continued)

safeguard systems such as fire detectors and suppression systems, (e.g., smoke detector and sprinklers), personnel training and administrative procedures to insure both control of radioactive materials and minimum personnel exposures. Fire suppression devices may not be necessary if combustible materials are minimal in the area.

(6) Provisions should be incorporated for collecting liquid drainage including provisions for sampling all collected liquids. Routing of the collected liquids should be to radwaste systems if contamination is detected or to normal discharge pathways if the water ingress was from external sources and remained uncontaminated

(7) Low level solidified waste stored in outside areas should be held securely by installed hold down systems. The hold down system should secure all containers during severe environmental conditions up to and including the design basis event for this waste storage facility.

(8) Container integrity should be assured against corrosion from the external environment; external weather protection should be included where necessary and practical storage containers should be raised off storage pads where water accumulation can be expected to cause external corrosion and possible degradation of container integrity.

(9) The quantity of radioactive material allowed and the shielding configurations will be dictated by the dose rate criteria for both the site boundary and unrestricted areas on-site. The 40 CFR 190 limits will restrict the annual dose from direct radiation and effluent releases to the Public (individual) to less than 25 mrem per year to the whole body from all sources of the Uranium fuel cycle; therefore, off-site doses from on-site storage must be sufficiently low to account for other sources (e.g., < 1 mrem/year). On-site dose limits associated to temporary storage will be controlled per 10 CFR Part 20 including the ALARA principle of 10 CFR 20.1.

(10) Total curie limits should be established based on the design of the storage area and the safety features provided.

(11) Inventory records of waste types, contents, dates of storage, shipment, etc., should be maintained.

V. Low Level Dry Waste Storage

(a) Low level dry waste is classified as contaminated material (e.g., paper, trash, air filters) which contains sources of radioactive material that is dispersed in small concentrations throughout large volumes of inert material which contain no free water. Generally, this consists of dry material such as rags, clothing, contaminated materials and small equipment (i.e., tools and instruments) which cannot be easily decontaminated.

EXHIBIT 7 (Continued)

(b) Licensees should implement controls to segregate and minimize the generation of Low Level Dry Waste to lessen the impact on waste storage. Integration of Volume Reduction (VR) hardware should be considered to minimize the need for additional waste storage facilities.

(c) The following design objectives and criteria are applicable for low level dry waste storage containers and facilities.

(1) All dry or compacted radwaste should be located in restricted areas where effective material control and accountability can be maintained. While structures are not required to meet seismic criteria, protection should be afforded to insure the radioactivity is contained safely by use of good engineering judgment.

(2) The waste container should be designed to insure radioactive material containment during normal and abnormal occurrences. The waste container materials should not support combustion. The packaged material should not cause fires through, spontaneous chemical reactions, retained heat, etc.

(3) Potential release pathways of all radionuclides present in the solidified waste form shall be monitored as per 10 CFR 50 Appendix A. Surveillance programs shall incorporate adequate methods for detecting failure of container integrity and measuring releases to the environment. For outside storage periodic direct radiation and surface contamination monitoring shall be conducted to insure that levels are below limits specific in 10 CFR 20.2029, 20.2051 and 49 CFR 173.397. All containers should be decontaminated to these levels or below before storage.

(4) Containers should generally comply with the criteria of 10 CFR 71 and 4 CFR 170 to minimize the need for repackaging for shipment.

(5) Increased container handling and personnel exposure can be anticipated, consequently, all ALARA methodology should be incorporated per Regulatory Guide 8.8 and 8.10.

(6) The quantity of radioactive material allowed and the shielding configurations will be dictated by the dose rate criteria for both the site boundary and unrestricted areas on-site. The 40.CFR 190 limits will restrict the annual dose from direct radiation and effluent release to the Public (individual) to less than 25 mrem per year to the whole body from all sources of the Uranium fuel cycle; therefore, off-site doses from on-site storage must be sufficiently low to account for other sources (e.g., <1 mrem/year). On-site dose limits associated to temporary storage will be controlled per 10 CFR Part 20 including the ALARA principle of 10 CFR 20.1.

(7) Total curie limits should be established based on the design of the storage area and the safety features provided.

EXHIBIT 7 (Continued)

(8) Provisions should be incorporated for collecting liquid drainage including provisions for sampling all collected liquids. Routing of the collected liquids should be to radwaste systems if contamination is detected or to normal discharge pathways if the water ingress was from external sources (e.g, rain water or moisture) and remained uncontaminated.

(9) Low-level waste stored in outside areas should be held securely by installed hold down systems. The hold down system should secure all containers during severe environmental conditions up to and including the design basis event for this waste storage facility.

(10) Container corrosion should be assured against from both the internal and external environment. Special internal liners and external weather protection should be included where necessary and practical. Storage containers should be raised off storage pads where water accumulation can cause external corrosion and resultant loss of container integrity.

(11) Inventory records of waste types, contents, dates of storage, shipment, etc., should be maintained.

These documents are designated as NUREGs and specific NUREG documents of interest for nuclear power plants include:

- **NUREG-0800**, *"Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR (Light Water Reactor), Edition,"* July, 1981 (as updated). The Standard Review Plan (SRP) is prepared for the guidance of staff reviewers in the Office of Nuclear Reactor Regulation in performing safety reviews of applications to construct or operate nuclear power plants. The principal purpose of the SRP is to assure the quality and uniformity of staff reviews and to present a well-defined base from which to evaluate proposed changes in the scope and requirements of reviews.

  The primary review of radwaste systems is performed by the Effluent Treatment System Branch (ETSB). At the construction permit (CP) stage, ETSB reviews the information in the applicant's preliminary safety analysis report (PSAR) in specific areas. During the operating license (OL) stage of the review, the ETSB review consists of confirming the design accepted at the CP stage and evaluating the adequacy of the applicant's technical specifications in these areas.

  As documented in Section 11.2 of the SRP, which covers the "Liquid Waste Management Systems", specific areas of ETSB's review include:

  (1) The liquid radwaste treatment system design, design objectives, design criteria, methods of treatment, expected releases, and principal parameters used in calculating the releases of radioactive materials in liquid effluents including the system piping and instrumentation diagrams (P&IDs) and process flow diagrams showing methods of operation and factors that influence waste treatment, e.g., system interfaces and potential bypass routes.

  (2) Equipment design capacities, expected flow and radionuclide concentrations, expected decontamination factors for radionuclides, and available holdup time.

  (3) The system design capacity relative to the design and expected input flows, and the period of time the system is required to be in service to process normal waste flows.

  (4) The availability of standby equipment, alternative processing routes, and interconnections between subsystems in order to evaluate the overall system capability to meet anticipated demands imposed by major processing equipment downtime and waste volume surges due to anticipated operational occurrences.

  (5) The quality group classifications of piping, and equipment, and the bases governing the design criteria chosen.

  (6) Provisions to prevent, control and collect releases of radioactive material in liquids due to tank overflows from all plant systems, outside reactor containment having the potential to incur such releases.

(7) Design and expected temperatures and pressures, and materials of construction of the components of the liquid waste management system.

(8) Design provisions incorporated in the equipment and facility design to reduce leakage and facilitate operation and maintenance in accordance with the guidelines of Regulatory Guideline 1.143.

(9) Design features that would reduce liquid input volumes or discharge of radioactive material in liquid effluents.

(10) Special design features that may be unique to the plant, topical reports incorporated by reference, and data obtained from previous experience with similar systems which are submitted with the SAR.

As documented in Section 11.3 of the SRP, which covers the "Gaseous Waste Management Systems", specific areas of ETSB's review include:

(1) The gaseous waste management (treatment and ventilation) system design, design objectives, design criteria, methods of treatment, expected releases, and principal parameters used in calculating the releases of radioactive materials (noble gases, radioiodine, and particulates) in gaseous effluents. The ETSB review will include the system piping and instrumentation diagrams (P&IDs) and process flow diagrams showing methods of operation and factors that influence waste treatment, e.g., system interfaces and potential bypass routes.

(2) Equipment and ventilation system design capacities, expected flows and radionuclide concentrations, expected decontamination factors for radionuclides, and available holdup time. The system design capacity relative to the design and expected input flows, the period of time the system is required to be in service to process normal waste flows, availability of standby equipment, alternate processing routes, and interconnections between subsystems. This information is used to evaluate the overall system capability to meet anticipated demands imposed by major processing equipment downtime and waste volume surges due to anticipated operational occurrences.

(3) The quality group classifications of piping and equipment, and the bases governing the design criteria chosen. Design and expected temperatures and pressures, and materials of construction of the components of the system.

(4) Design provisions incorporated in the equipment and facility design to facilitate operation and maintenance in conformance with the guidelines of Regulatory Guideline 1.143.

(5) Special design features to reduce leakage of gaseous waste or discharge of radioactive material in gaseous effluents. Special design features, topical reports

incorporated by reference, and data obtained from previous experience with similar systems which are submitted with the SAR.

(6) Design features to preclude the possibility of an explosion if the potential for explosive mixtures exists.

As documented in Section 11.4 of the SRP, which covers the “Solid Waste Management Systems”, specific areas of ETSB’s review include:

(1) The design objectives in terms of expected and design volumes of waste to be processed and handled, the wet and dry types of waste to be processed (e.g., sludges, resins, evaporator bottoms, and dry material such as contaminated tools, equipment, rags, paper, and clothing), the activity and expected radionuclide distribution contained in the waste, equipment design capacities, and the principal parameters employed in the design of the solid waste system (SWS).

(2) The description of the SWS, the piping and instrumentation diagrams (P&IDs), and the process flow diagrams showing the methods of operation, the expected chemical content and radionuclide concentrations of liquid wastes to be processed and handled by the SWS, and the expected volumes to be returned to the liquid radwaste system for further treatment.

(3) The description of the methods for solidification (i.e., removal of free water), the description of the methods for dewatering, the solidifying agent used, and the implementation of a process control program to ensure a solid matrix and proper waste form characteristics and/or complete dewatering.

(4) The description of the type and size of solid waste containers; the method of filling, handling, and monitoring for removable radioactive contamination; and provisions for decontamination, packaging, and storage.

(5) The provisions for the on-site storage of solid wastes, the expected and design volumes, the expected radionuclide contents, and the design bases for these values.

(6) The quality group classifications of piping and equipment, and bases governing the classification chosen.

(7) Design provisions incorporated in the equipment and facility design to reduce leakage and facilitate operation and maintenance.

(8) Special design features, referenced topical reports, and previous experience with similar equipment and methods referenced in the SAR.

(9) The consequences of a liquid tank failure having the potential to release radioactive materials to a potable water supply as part of its review responsibility under SRP Section 15.7.3.

The ETSB coordinates its review of the liquids, gaseous, and solids waste treatment systems with other branches within the NRC and the SRP explains the interrelationships. The SRP also provides additional acceptance criteria, specific criteria, and Branch Technical Position Papers to support the NRC staff in their review of the licensee's applications. (Sections 11.1 - 11.4 of the SRP are attached.)

Other (non-NUREG) documents include the following management directives and inspection manuals:

- **Management Directive 8.6** - "*Systematic Assessment of Licensee Performance (SALP).*" This document explains how the NRC uses the Systematic Assessment of Licensee Performance (SALP) process to articulate the agency's observations and insights on the licensee's safety performance. The SALP report communicates those observations and insights to licensee management and the public. The objectives of the SALP process are four-fold:

  - To conduct an integrated assessment of licensee safety performance that focuses on the safety significance of the NRC findings and conclusions during an assessment period.

  - To provide a vehicle for meaningful dialogue with the licensee regarding its safety performance based on the insights gained from synthesis of NRC observations.

  - To assist NRC management in making sound decisions regarding allocation of NRC resources used to oversee, inspect, and assess licensee performance.

  - To provide a method for informing the public of the NRC's assessment of licensee performance.

  Additional information regarding the SALP reporting process is presented below.

The inspection procedures used by the NRC inspectors is documented in a collection of "Inspection Procedures." The applicable inspection procedures for use at nuclear power facilities, include:

- **Inspection Procedure 65051**, "*Low-Level Radioactive Waste Storage Facilities.*" This inspection procedure is applicable for the both the construction and operation of low-level radioactive waste (LLRW) storage facilities at nuclear power plants. The objectives of this procedure is to allow the inspector to:

NRC's General Inspection Philosophy

In general, because the safety significance of LLRW storage facilities--especially for low-level dry waste storage--is low, extensive inspection efforts are not warranted. Factors to consider when determining the inspection scope include: size of the structure(s), complexity of design or construction, type of radioactive waste to be stored (wet, solidified wet, or dry low-level), within or outside the plant protected area, and the extent of prior NRC review. Consequently, the guidance of this procedure should be applied in a graded approach consistent with the potential for impact of facility operation on personnel health and safety on site and offsite.

(1) Determine whether the licensee has provided an adequate safety evaluation for construction and operation of the facility.

(2) Determine whether quality assurance plans, instructions, and procedures have been established.

(3) Determine whether adequate construction procedures have been established.

(4) Determine whether construction of the as-built facility was consistent with NRC requirements and licensee commitments.

(5) Determine whether changes to organization and staffing because of the LLRW storage facility agree with applicable requirements of the Technical Specifications and with FSAR and other licensee commitments.

(6) Determine whether an effective training and qualification program exists for personnel assigned to the LLRW storage facility.

(7) Determine whether adequate procedures have been established for routine operation of the LLRW storage facility.

(8) Determine whether there have been any changes to the facility and facility operations that could affect effluent monitoring requirements.

- Inspection Procedure 84101, "Radioactive Waste Management." This inspection procedure is used to determine the adequacy of the licensee's radioactive waste management for the SAFSTOR or DECON option. The objectives of this procedure is to allow the inspector to:

(1) Audits and Appraisals. Review the results of audits and appraisals performed by or for the licensee since the last inspection and the adequacy of the licensee's procedures, commitments, and corrective actions taken.

(2) Changes. Review changes in equipment, facility, procedures and operations for liquid, airborne and solid waste systems. Determine whether changes are in accordance with 10 CFR 50.59 and license requirements.

(3) Radioactive Liquid Effluents

a. Determine compliance with effluent requirements and efforts to keep effluents ALARA.

b. Determine by observation whether the liquid waste systems incorporate provisions to prevent and collect leakage, overflows, and spillage in accordance with the licensee approved safety analysis report.

(4) Radioactive Airborne Effluents

a. Determine compliance with effluent requirements and efforts to keep effluents ALARA.

b. Determine whether normal and special ventilation exhaust system air cleaning units are maintained and operated as required by the license procedures and Technical Specifications (TS).

(5) Instrumentation and Systems

a. Determine whether process and effluent monitors are maintained, and calibrated as required by the license procedures and TS.

(6) Radioactive Solid Waste

a. Determine that the processing, control, and storage of solid wastes is in accordance with the license procedures, safety analysis TS, and applicable Federal and State regulations.

b. Determine that the procedures for proper classification and characterization of wastes, for preparation of waste manifests, for marking packages with the class of waste, and for investigation of lost shipments are in accordance with regulatory requirements.

- **Inspection Procedure 84522**, *"Solid Wastes (Preoperational and Supplemental)."* This inspection procedure is used to determine whether the components and installation of the solid waste systems are as described in the FSAR and whether the applicant has conducted preoperational tests of these waste systems to verify operability. The inspectors look at the following:

(1) Solid Waste System Construction and Installation. Verify that the solid waste system is built and installed as described in the FSAR and that solid waste system components, piping, and waste storage areas have been adequately shielded.

(2) Liquid Leakage, Overflow, and Spillage. Determine the adequacy of solid waste system design provisions to prevent and collect leakage, overflows, and spillage.

(3) Sampling. Determine the adequacy of provisions for sampling waste before and after processing.

(4) Test Program for Solid Waste System. Determine the adequacy of the test program for the solid waste system and observe the performance of preoperational tests on the system.

(5) Test Completion for Solid Waste System. Determine whether appropriate tests of the solid waste system have been completed.

(6) Process Monitors. Determine adequacy of installation, calibration, and testing of process monitors for the solid waste system.

(7) Programs, Plans, and Procedures for Solid Waste System. Determine the adequacy of the applicant's documented programs (including Process Control Program), plans and procedures for the solid waste system.

(8) Disposal of Low-Level Wastes. Verify that the licensee has established (or will establish prior to shipping radioactive wastes) procedures for proper classification and characterization of wastes, for preparation of waste manifests, marking of packages with the class of waste, and investigation of lost shipments.

- **Inspection Procedure 84523**, *"Liquids and Liquid Wastes (Preoperational and Supplemental)."* This inspection procedure is used to determine whether the components and installation of the liquid waste systems are as described in the FSAR; whether the applicant has conducted preoperational tests of these waste systems to verify operability; whether the applicant's liquid effluent and process monitoring program is adequate and conforms to the FSAR description; whether preoperational, startup, and operational procedures have been written and approved; and whether procedures, instrumentation, and equipment to sample and handle radioactive liquids under accident conditions are adequate and operational. The inspectors look at the following:

(1) Liquid Waste System Construction and Installation. Verify that the liquid waste system is built and installed as described in the FSAR and that liquid waste system components have been adequately shielded.

(2) Liquid Leakage, Overflow, and Spillage. Determine by observation whether the liquid waste system incorporates provisions to prevent and collect leakage, overflows, and spillage.

(3) Liquid Sampling

a Determine the adequacy of primary coolant, process and effluent liquid sampling systems for normal operations.

b. Determine the adequacy of provisions for sampling primary coolant (post-accident sampling system), process liquids, and effluents under accident conditions.

(4) Test Program for Liquid Waste System. Determine whether the test program for the liquid waste system is adequate and observe the performance of preoperational tests of the liquid waste system.

(5) Test Results Completion for Liquid Waste System. Determine whether appropriate tests of the liquid waste system have been completed.

(6) Liquid Process and Effluent Monitors. Determine the adequacy of installation, calibration, and testing of liquid process and effluent monitors for the liquid waste system.

(7) Programs, Plans and Procedures for Liquid Waste and Effluent Systems. Determine the adequacy of the applicant's documented programs, plans, and procedures for liquid waste and effluent systems for normal operations.

- **Inspection Procedure 84524**, *"Gaseous Waste System (Preoperational and Supplemental)."* This inspection procedure is used to determine the gaseous waste system is as described in the FSAR; whether the applicant has conducted preoperational tests of waste systems to verify their operability; whether the applicant's effluent and process monitoring program is adequate and conforms with the FSAR description; whether procedures, instrumentation, and equipment to sample and handle radioactive gases and particulates are adequate and operational under accident conditions; and whether preoperational, startup, and operational procedures have been written and approved. The inspectors look at the following:

(1) Construction and Installation. Verify that the gaseous waste system is built and installed as described in the FSAR and that gaseous waste system components have been adequately shielded.

(2) Sampling. Determine adequacy of sampling systems for normal operations and of post-accident sampling of containment air.

(3) Test Program. Determine whether the testing program for the gaseous waste management system is adequate and observe the performance of preoperational tests of the waste management systems.

(4) Test Completion. Verify that appropriate tests of the waste gas, purge, and ventilation systems have been completed.

(5) Process and Effluent Monitors. Determine adequacy of installation, calibration, and testing of process and effluent monitors for gases and airborne particles.

(6) Programs, Plans, and Procedures. Determine adequacy of the applicant's documented programs, plans, and procedures for normal operations.

- **Inspection Procedure 84722**, *"Solid Wastes"*. This inspection procedure is used to determine whether the licensee effectively controls and quantifies radioactive solids during normal and emergency operations. The inspectors look at the following:

(1) Audits and Appraisals. Review the results of audits and appraisals performed by or for the licensee since the last inspection and the adequacy of the licensee's commitments and corrective action.

(2) Changes. Review change in equipment and procedures and determine whether changes are in accordance with 10 CFR 50.59.

(3) Processing and Storage. Determine the adequacy of processing, control and storage of solid wastes.

(4) Disposal of Low-Level Wastes. If the licensee has disposed of low-level radioactive waste, determine whether the licensee has established procedures for proper classification and characterization of wastes, for preparation of waste manifests, marking of packages with the class of waste, and investigation of lost shipments.

- **Inspection Procedure 84723**, *"Liquids and Liquid Wastes"* The purpose of this inspection procedure is for the inspector to determine whether the licensee effectively controls and quantifies radioactive liquids. The inspector looks at the following:

(1) Audits and Appraisals. Review the results of audits and appraisals performed by or for the licensee since the last inspection and the adequacy of the licensee's commitments and corrective action.

(2) Changes. Review changes in equipment and procedures used for normal and emergency (post-accident sampling system) operation and determine whether changes are in accordance with 10 CFR 50.59.

(3) Effluents. Determine compliance with effluent requirements and efforts to keep effluents ALARA.

(4) Instrumentation. Determine whether process and effluent monitors are maintained, calibrated, and operated as required.

(5) Reactor Coolant and Secondary Water. Determine whether reactor coolant water and, for PWRs, secondary water meets chemical and radiochemical requirements.

- **Inspection Procedure 84724**, *"Gaseous Waste System"*. The purpose of this inspection procedure is to determine whether the licensee effectively controls and quantifies radioactive gases and particulates during normal and emergency operations. The inspector looks at the following:

(1) Audits and Appraisals. Review the results of audits and appraisals performed by or for the licensee since the last inspection and the adequacy of the licensee's commitments and corrective action.

(2) Changes. Review changes in equipment and procedures used for normal and emergency (including Post-Accident Sampling System) operation and determine whether changes are in accordance with 10 CFR 50.59.

(3) Effluents. Determine compliance with effluent requirements and efforts to keep effluents ALARA.

(4) Instrumentation. Determine whether process and effluent monitors are maintained, calibrated, and operated as required.

- **Inspection Procedure 84750**, *"Radioactive Waste Treatment, and Effluent and Environmental Monitoring"*. The purpose of this inspection procedure is to enable the inspector to:

(1) Ensure that radioactive waste treatment systems are maintained and operated to keep offsite doses ALARA.

(2) Ensure that the licensee effectively controls, monitors, and quantifies releases of radioactive materials in liquid, gaseous, and particulate forms to the environment.

(3) Ensure that radiological environmental monitoring programs are effectively implemented.

(4) Determine whether the licensee is adequately controlling the quality of primary and secondary coolants to ensure long-term integrity of the reactor and secondary coolant pressure boundaries and minimize out-of-core radiation field buildup.

(5) Ensure that engineered-safety-feature (ESF) atmosphere cleanup system air filtration and adsorption units are adequately tested and maintained as specified in the Technical Specifications (TSs).

- **Inspection Procedure 84850**, *"Radioactive Waste Management - Inspection of Waste Generator Requirements of 10 CFR Part 20 and 10 CFR Part 61."* The purpose of this inspection procedure is to enable the inspector to determine whether the licensee has established and is maintaining adequate management-controlled procedures and quality assurance that reasonably ensure compliance with the requirements of 10 CFR Part 20 and 10 CFR Part 61 applicable to low-level radioactive waste (radwaste) form, classification, stabilization, and shipment manifests/tracking. The inspectors look at the following:

(1) Management Controls. Review the licensee's written procedures for radwaste processing, specifically identifying the primary documentation thereof. Verify that the following aspects are adequately addressed:

a. That the individual(s) and organizational entities that have been assigned the responsibility for radwaste processing for low-level land burial have been clearly designated in writing;

b. That there has been a clear delineation of the authorities and responsibilities of those individuals and organizational entities;

c. That written management-approved instructions have been established to carry out the various radwaste processing and packaging activities, including authorized changes thereto, and the promulgation/distribution of such instructions to the appropriate line/staff organization.

(2) Quality Assurance (QA). Verify that the licensee has established and maintains an adequate QA program to ensure compliance with the waste classification and characterization requirements of 10 CFR 61.55 and 61.56. Verify whether the QA program includes the required audits and management evaluation of such audits. Review the results of the most recent audit and corrective actions [Subsection III.A.3 of Appendix F to 10 CFR 20.1001-20.2401].

For nuclear power plant licensees, QA activities related to implementation of 10 CFR Part 61, 10 CFR 20.2006 and Appendix F to 10 CFR 20.1001-20.2401 are not required to be included under the licensee's corporate level QA program for "Nuclear Safety Related" items.

(3) Waste Manifests. Review the licensee's procedures and records to verify that each shipment of radwaste intended for offsite disposal to a broker or a licensed land disposal facility is accompanied by a shipment manifest that includes all the required information [10 CFR 20.2006(b) and (c)].

(4) Waste Classification. Review the licensee's documentation and records of activities that have been established and are being maintained, to ensure that all low-level radwastes are properly classified according to 10 CFR 61.55. Verify whether such efforts reasonably ensure that a realistic representation has been accomplished [Subsection III.A.1 of Appendix F to 10 CFR 20.1001-20.2401].

(5) Waste Form and Characterization. Review the licensee's documentation and records of activities, which have been established and are being maintained, to ensure that all low-level radwaste meets the waste characteristics of 10 CFR 61.56. Verify whether the methods and determinations of the licensee provide reasonable assurance that the waste form requirements are met [Subsection III.A.1 of Appendix F to 10 CFR 20.1001-20.2401].

(6) Waste Shipment Labeling. Review the licensee's procedures and records to verify that each package of radwaste intended for shipment to a licensed land disposal facility is labeled, as appropriate, to identify it as Class A, B, or C waste in accordance with the classification criteria of 10 CFR 61.55 [Subsection III.A.2 of Appendix F to 10 CFR 20.1001-20.2401].

(7) Tracking of Waste Shipments. Review the licensee's procedures and records, to verify that a system has been established to forward to recipients or deliver to waste collectors, at the time of shipment, a copy of the waste manifest. Verify that acknowledgment of receipt of the manifest is obtained. Verify that the licensee has a procedure in place to effect an investigation in any instances wherein acknowledgment of receipt of shipment has not been received within the specified period. Verify that procedures are in place to report such investigations to the appropriate NRC Regional Office and file the required written report. [Subsections III.A, III.B, III.C, and III.E of Appendix F to 10 CFR 20.1001-20.2401].

(8) Disposal Site License Conditions. Review the licensee's procedures and records to verify that the applicable disposal site license conditions are being met. Verify that the licensee has on file a current version of the disposal site license.

- **Inspection Procedure 84900**, *"Low-Level Radioactive Waste Storage"*. The purpose of this inspection procedure is to enable the inspector to determine whether fuel cycle and materials licensees who store low-level radioactive waste (LLW) are doing so safely and in accordance with license conditions. This procedure may be applied to any licensee who stores LLW, regardless of when the storage facility was established. The requirements of this procedure are separate from and in addition to those of Inspection Procedure 84850, which addresses the establishment and maintenance of procedures and quality assurance with respect to the waste form, classification, stabilization and manifest requirements of 10 CFR Part 20 and 10 CFR Part 61. Inspectors look at the following:

(1) Management Controls and Surveys. Review the license file and identify any special authorizations and requirements for LLW storage. Determine where LLW is being stored. Review how long the LLW has been stored and examine the licensee's accountability and security procedures for the waste. Determine whether the licensee is in compliance with possession limits. Review the licensee's procedures for safe placement, inspection and repackaging of LLW in storage. Verify that the licensee has conducted and properly documented: (1) inspections of LLW packages to assure they maintain integrity; (2) radiation surveys of individual packages and the storage area, in general; and (3) any required effluent sampling. Review the licensee's records for waste placed in storage and assure that they are adequate and that LLW is accounted for.

(2) Adequacy of Storage Area. Inspect the storage area(s) to assure its adequacy with respect to:

a. Access control and security.

b. Access to, and housekeeping around waste packages. Adequate visibility should be provided to permit identification of unsafe conditions.

c. Stable placement of waste or waste packages.

d. Protection from environmental elements, fire and flooding, avoidance of temperature/humidity extremes, and ventilation considerations.

e. Posting and labeling.

(3) Package Integrity and Labeling. Examine several waste packages to determine that the packages are adequate for the expected term of storage. Assure that they are maintaining their integrity and are properly labeled.

- **Inspection Procedure 86750**, *"Solid Radioactive Waste Management and Transportation of Radioactive Materials"*. The purpose of this inspection procedure is for the inspector to (1) determine whether the licensee properly processes, packages, stores, and ships radioactive materials, and (2) provide for identification of potential public health and safety problems resulting from the processing, packaging, and shipment of low-level radioactive waste (LLRW) for disposal and from the transportation of other radioactive materials. The inspectors look at five major areas:

(1) Audits and Appraisals; Effectiveness of Licensee Controls

a. Review results of audits performed by or for the licensee since the last inspection and evaluate the adequacy of the licensee's corrective actions. In particular, review those audits conducted to meet the applicable Technical Specification (TS), and 10 CFR Parts 20, 61, and 71 requirements for processing LLRW, and for packaging and shipping LLRW and other radioactive materials. Determine whether the reviewed audits have been conducted in accordance with plant requirements.

b. Review management evaluations of audits conducted as part of the quality control program to ensure compliance with 10 CFR §§ 61.55 and 61.56 [in accordance with 10 CFR 20.2006(d) and § III.A.3 of Appendix F to 10 CFR Part 20 §§ 20.1001-20.2402]; and, as applicable, those audits conducted to meet 10 CFR 71, Subpart H requirements. Determine whether management response was timely and appropriate.

c. Evaluate the effectiveness of licensee controls in the area of processing and shipment of solid LLRW and transportation of other radioactive materials by reviewing pertinent issues, events, or problems identified or addressed during the inspection.

d. Determine whether there are strengths or weaknesses in the licensee's controls for the identification and resolution of the reviewed issues that could degrade plant operations or safety.

(2) Changes

a. Review major changes since the last inspection in organization, personnel, facilities, equipment, programs, and procedures that may affect solid LLRW waste management and transportation of radioactive materials.

b. Evaluate the effects of any changes on program effectiveness.

(3) Training and Qualifications of Personnel

a. Review the applicable education, experience, qualifications and training of selected employees of the licensee (and its contractors) that are responsible for processing, testing, storage, and shipping (including certification) of LLRW and transportation of other radioactive materials.

b. Determine if the licensee has provided training and periodic retraining in the DOT and NRC regulatory requirements, the waste burial license requirements, and in the instructions and operating procedures for all personnel involved in the transfer, packaging and transport of radioactive waste.

c. Determine if the licensee has provided training and periodic retraining to those employees of the licensee (and its contractors) who operate the processes that generate radioactive waste to ensure that the volume of waste is minimized and is processed into acceptable chemical and physical form for transfer and shipment to a LLRW burial facility.

d. Determine if the licensee has incorporated the results of "lessons learned," as a result of any violations and corresponding corrective action which may have occurred since the last inspection, into lesson plans for employees who operate low-level waste processing equipment or for personnel involved in the transfer, packaging and transport of radioactive material.

(4) Implementation of the Solid Radioactive Waste Program

a. Determine if the licensee has up-to-date copies of DOT, NRC and the competent state authority regulations and up-to-date copies of the licenses of all facilities to which the licensee ships radioactive materials or wastes.

b. Determine if the licensee has provided management approved, detailed instructions and operating procedures for all personnel involved in the transfer, packaging and transport of low-level radioactive waste with special attention given to controls on the chemical and physical form of the radioactive material and on the containment integrity of the packaging. Determine if the licensee has identified (preferably in writing) those individuals authorized to certify LLRW shipments in accordance with Section II of Appendix F to 10 CFR 20.1001-20.2402.

c. Determine the adequacy of the basis for the licensee's certifications under Section II of Appendix F to 10 CFR 20.1001-20.2402 that wastes intended for eventual disposal at a land disposal facility are properly classified, described, packaged, marked, and labeled and are in proper condition for transportation. Determine that the Class B and Class C wastes have been shown to be structurally stable, in accordance with the requirements of 10 CFR 61.56(b). Verify that the licensee is using up-dated and audited procedures when scaling factors or correlation factors are used to quantify the concentration of hard-to-measure radionuclides in materials or for classification of wastes.

(5) <u>Shipping of LLRW for Disposal, and Transportation of other Radioactive Material</u>

a. Determine whether shipments made by the licensee are in compliance with the NRC and DOT regulations.

b. Determine the adequacy of licensee actions in response to notices of non-compliance from DOT or other competent state authorities, if applicable.

- **Inspection Procedure 88035**, *"Radioactive Waste Management"*. The purpose of this inspection procedure is for the inspector to determine whether the licensee is complying with regulations and license requirements related to the release and disposal of liquid, airborne, and solid waste, and the reporting of waste disposal information to the NRC. The inspector looks at the following:

(1) <u>Radioactive liquid effluents</u>. Determine compliance with the following listed regulations and/or license requirements applicable to the facility:

a. 10 CFR 20.106 [release to unrestricted areas]

b. 10 CFR 20.303 [release into sanitary sewerage]

c. license requirements for:
1. limits on release rates, concentrations, and total quantities,
2. analysis for specific radionuclides,
3. monitoring of specified release points, and
4. any limits on activity contained in holding or storage tanks.

(2) <u>Radioactive airborne effluents</u>. Determine compliance with the following listed regulations and/or license requirements applicable to the facility:

a. 10 CFR 20.106 [release to unrestricted areas]

b. license requirements for:
1. limits on release rates, concentrations, and total quantities,

2. analysis for specific radionuclides,
3. monitoring of specified release points, and
4. any limits on activity contained in holding or monitoring tanks.

(3) Records and reports of radioactive effluents. Determine compliance with the following listed regulations and/or license requirements applicable to the facility:

a. 10 CFR 40.65 [effluent reporting requirements]

b. 10 CFR 70.57 [effluent reporting requirements]

c. 10 CFR 20.401 [records of ... disposal]

d. license requirements for:
1. effluent reports, in terms of frequency and content, and
2. maintenance of records

(4) Liquid and airborne effluent monitoring instruments. Determine compliance with license requirements for:

a. calibrations and functional tests,

b. correlation of monitor reading and laboratory measurement of radioactivity in the release path, and

c. settings for trips and alarms.

(5) Procedures for controlling the release of effluents

a. Review all the changes in effluent control procedures made since the last inspection and verify that:

1. they were made in accordance with the licensee's procedural control system and reviewed and approved by management and supervision, and
2. they afford the same or a higher level of control of effluents as the procedures reviewed during previous inspections.

b. Determine whether the licensee is following his effluent control procedures.

(6) Radioactive solid waste. Determine compliance with the following listed regulations and/or license requirements applicable to the facility.

a. 10 CFR 20.203 [caution signs, labels]

b. 10 CFR 20.301 [general requirements for disposal]

c. 10 CFR 20.401 [records of ... disposal]

d. license requirements for:
   1. use of specified containers and packages,
   2. identification of the quantity and radionuclide composition of waste in containers and packages,
   3. records of waste shipments and waste in storage, and
   4. reports of solid waste shipment and waste in storage.

Copies of all the above referenced documents (Regulatory Guides, Generic Communications, NRC Reports, and Inspection Procedures) are provided in Attachment 1 of this background document. Copies the applicable 10 CFR Chapter I regulations (and the above referenced documents) can be obtained either from NRC's Internet web page at: **http://www.nrc.gov** or the NRC Public Document Room, at 2120 L Street, NW, Lower Level, Washington, DC 20037.

2.4 Summary of Licensing Process

The domestic licensing of nuclear power plants is covered under 10 CFR Part 50, and the process for obtaining a license to operate is briefly described below.

2.4.1. Initial License

As part of the licensing process, the applicant submits an application for an operating license (which is granted in two phases - construction permit and operating license). The application must contain all of the information required by 10 CFR 50.33. In addition, as per 10 CFR 50.34, the applicant also must present a Safety Analysis Report, which in the initial phase of licensing is termed the "Preliminary Safety Analysis Report (PSAR). The PSAR must be sufficiently detailed to permit the NRC to determine whether the plant can be built and operated without undue risk to the health and safety of the public. Prior to submission of an PSAR, an applicant should have designed and analyzed the plant in sufficient detail to conclude that it can be built and operated safely.

The SAR is the principal document in which the applicant provides the information needed to understand the basis upon which this conclusion has been reached. Section 50.34 specifies, in general terms, the information to be supplied in a SAR. The specific information required by the staff for an evaluation of an application is identified in Regulatory Guide 1.70, "Standard Format and Content of Safety Analysis Reports for Nuclear Power Plants - LWR Edition." The Standard Review Plan (SRP) sections are keyed to the Standard Format, and the SRP sections are numbered according to the section numbers in the Standard Report. For the purposes of this background document, the most relevant section of the SAR is Chapter 11. Chapter 11 is where the applicant details how (and where) radioactive liquids, gases, and solid wastes are going to be managed on-site (treatment and storage). The information contained in Chapter 11 of the SAR is discussed in greater detail below.

The NRC uses NUREG-0800, "Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants," to guide their review of the applicant's PSAR. If the PSAR is determined to be adequate, and after a public comment process, the NRC grants a construction permit (CP). The applicant can then begin construction of their nuclear power plant.

Once the construction of the nuclear power plant has reached the point where all of the design details have been worked out and the plans for operation of the facility have been finalized, the applicant then submits, as an amendment to their initial application), a Final Safety Analysis Report (FSAR) to the NRC for review. If the NRC determines that an operating license should be granted, the NRC holds a public hearing, resolves any public concerns, and then grants an operating license. The operating license generally incorporates two appendices. The first appendix is the "Technical Specifications," which details the operation of the plant. The second appendix is the "Environmental Protection Plan." This plan provides for the protection of the non-radiological environment and, when followed, ensures that the plant is operated in an environmental acceptable manner in accordance with the plant's Final Environmental Statement and other Federal, state, and local requirements for environmental protection.

2.4.2 License Renewal

The Atomic Energy Act and NRC regulations limit commercial power reactor licenses to 40 years, but also permit such licenses to be renewed. The original 40-year term was selected on the basis of economic and antitrust considerations--not by technical limitations--but once selected, individual plant designs may have been engineered on the basis of an expected 40-year service life.

The first 40-year operating license will expire in the year 2006; approximately 10 percent of the rest will expire by the end of the year 2010 and more than 40 percent will expire by the year 2015.

License renewal requirements for power reactors are based on two key principles: (1) the regulatory process, continued into the extended period of operation, is adequate to ensure that the licensing basis of all currently operating plants provides an acceptable level of safety, with the possible exception of the detrimental effects of aging on certain systems, structures, and components, and possibly a few other issues related to safety only during the period of extended operation, and (2) each plant's licensing basis is required to be maintained during the renewal term.

A nuclear power plant licensee may apply to the NRC to renew its license for up to 20 years. As early as 20 years before the expiration of its current license, an applicant may apply to extend its license. It is estimated that it would take a licensee between 3 and 5 years to prepare an application. The application would be subject to public hearings--a formal, adjudicatory process. It is expected that the NRC staff, will need between 3 and 5 years to complete a detailed technical review and for the hearing process to be completed.

Environmental and technical requirements for the renewal of power reactor operating licenses are contained in NRC's regulations, 10 CFR Parts 51 and 54, respectively. The environmental protection regulations in 10 CFR Part 51 were revised on December 18, 1996, to facilitate the environmental review for license renewal. Part 54 was revised in May 1995 to simplify and clarify the license renewal scope and process.

2.5 NRC Oversight

The NRC generally has three (or more) resident inspectors at every nuclear power facility. In 1996, NRC inspectors logged an average 4,100 hours at every facility (the range was between <2,000 hours to as much as <9,500 hours).[10] Resident inspectors prepare both daily reports and six week reports to note operational events. NRC regional inspectors participate in the inspection of both specialized areas and overall plant operation as part of the Systematic Assessment of Licensee Performance (SALP) process. Both the resident inspectors and regional inspectors use the numerous Inspection Procedures prepared by NRC (as described above in Section 2.3.4) to ensure that the plants are operating in a manner that is safe to human health and the environment.

2.5.1 Systematic Assessment of Licensee Performance

---

[10] Information Digest, NRC, NUREG-1350, Volume 9, pages 30 and 39.

NRC uses the Systematic Assessment of Licensee Performance (SALP) process to articulate the agency's observations and insights on the licensee's safety performance. The SALP report communicates those observations and insights to licensee management and the public. The objectives of the SALP process are four-fold:

- To conduct an integrated assessment of licensee safety performance that focuses on the safety significance of the NRC findings and conclusions during an assessment period.

- To provide a vehicle for meaningful dialogue with the licensee regarding its safety performance based on the insights gained from synthesis of NRC observations.

- To assist NRC management in making sound decisions regarding allocation of NRC resources used to oversee, inspect, and assess licensee performance.

- To provide a method for informing the public of the NRC's assessment of licensee performance.

NRC reviews and evaluates each power reactor licensee that possesses an operating license or a construction permit at an interval of 12 to 24 months. The regional administrator shall determine the exact frequency within this interval on the basis of the licensee's performance and regional scheduling needs, with the following exceptions:

- When a new operating license is issued, two consecutive SALP evaluations will be scheduled at approximately 12-month intervals after issuance of the low-power license. Following completion of these two evaluations, the appropriate regional administrator will determine whether to place the licensee on a longer SALP assessment period.

- The assessment period shall be 24 months when a plant receives a Category 1 rating in the functional areas of Plant Operations, Maintenance, Engineering, and Plant Support. The 24-month assessment period is conditional upon continued superior performance. The Director, Office of Nuclear Reactor Regulation (NRR), will be informed in writing when a subsequent reduction is made to the 24-month assessment period as a result of a decline in performance.

- SALP frequency and the scope of the assessment may be adjusted for plants in extended shutdowns, extended outages, or decommissioning. In each case, the regional administrator shall confer with the Director, NRR, and document the basis for the change.

- The SALP process will be suspended for any plant that is shut down and requires authorization by the Commission (not the staff) to restart. As a part of a restart review process, an ungraded evaluation of performance in the SALP functional areas may be performed.

- Each reactor site will have a separate assessment. For plants at one site in different stages (construction or operating), individual assessments will be performed. For other multiple unit sites, the regional administrator will determine if individual assessments are necessary to capture and communicate the NRC's assessment of licensee performance.

Functional areas represent a grouping of similar licensee activities. The four standard functional areas for operating reactors are:

- Plant Operations. This functional area consists chiefly of the control and execution of activities directly related to operating a plant. It includes activities such as plant startup, power operation, plant shutdown, and system lineups. Thus, it includes activities such as monitoring and logging plant conditions, normal operations, response to transient and off-normal conditions, adequacy and implementation of emergency operating procedures and abnormal operating procedures, manipulating the reactor and auxiliary controls, and control room professionalism. It also includes initial and requalification training of licensed operators.

- Maintenance. This functional area includes all activities associated with either diagnostic, predictive, preventive, or corrective maintenance of plant structures, systems, and components, or maintenance of the physical condition of the plant, and training of the maintenance staff. It also includes conduct of all surveillance testing activities, all inservice inspection and testing, instrument calibrations, equipment operability tests, post-maintenance testing, post-outage testing, containment leak rate tests, and special tests.

- Engineering. This functional area addresses the adequacy of technical and engineering support for all plant activities. It includes all licensee activities associated with design control; the design, installation, and testing of plant modifications; engineering and technical support for operations, outages, maintenance, testing, surveillance, and procurement activities; configuration management; design-basis information and its retrieval; training of the engineering staff; and support for licensing activities.

- Plant Support. This functional area includes all activities related to plant support functions, including radiological controls, emergency preparedness, security, chemistry, and fire protection. It includes all activities associated with occupational radiation safety, radioactive waste management, radiological effluent control and monitoring, transportation of radioactive materials, licensee performance during emergency preparedness exercises and actual events that test emergency plans, emergency plan notifications, interactions with on site and offsite emergency response organizations during exercises and actual events, and safeguards measures that protect plant equipment, including physical security, fitness for duty, access authorization, and control of special nuclear material. Housekeeping controls and training of the staff are included in this area.

Unique licensee activities, such as dry cask storage, may be discussed under the functional area that most closely matches the underlying performance issue. In addition, other functional areas may be considered for specific situations. For example, when plants are in extended shutdowns, it may be more appropriate to address shutdown operations in lieu of plant operations. For readiness assessments, SALP boards may need to consider activities that take place over a shorter interval, such as startup testing.

Licensee performance in each functional area is assessed by assigning a category rating. Licensees assigned a Category 1 rating in a functional area have clearly demonstrated superior safety performance, which justifies some relaxation in NRC oversight, whereas licensees assigned a Category 3 rating in a functional area are of concern to NRC even though they have demonstrated acceptable safety performance. The NRC will consider additional interaction with and oversight of the licensee in the affected area. The final rating for each functional area will be a composite rating of performance based on a knowledgeable balancing of the issues in a functional area and their safety significance.

The category ratings are as follow:

- *Category 1*. Licensee attention and involvement have been properly focused on safety and resulted in a superior level of safety performance. Licensee programs and procedures have provided effective controls. The licensee's self-assessment efforts have been effective in the identification of emergent issues. Corrective actions are technically sound, comprehensive, and thorough. Recurring problems are eliminated and resolution of issues is timely. Root cause analyses are thorough.

- *Category 2*. Licensee attention and involvement are normally well focused and resulted in a good level of safety performance. Licensee programs and procedures normally provide the necessary control of activities, but deficiencies may exist. The licensee's self-assessments are normally good, although issues may escape identification. Corrective actions are usually effective, although some may not be complete. Root cause analyses are normally thorough.

- *Category 3*. Licensee attention and involvement have resulted in an acceptable level of safety performance. However, licensee performance may exhibit one or more of the following characteristics. Licensee programs and procedures have not provided sufficient control of activities in important areas. The licensee's self-assessment efforts may not occur until after a potential problem becomes apparent. A clear understanding of the safety implications of significant issues may not have been demonstrated. Numerous minor issues combine to indicate that the licensee's corrective action is not thorough. Root cause analyses do not probe deep enough, resulting in the incomplete resolution of issues. Because the margin to unacceptable performance in important aspects is small, increased NRC and licensee attention is required.

- *Category N.* Insufficient information exists to support an assessment of licensee performance. These cases include instances in which a rating cannot be developed because of insufficient licensee activity or insufficient NRC inspection. This category is normally used for construction phase reactors only.

A summary of the most recent SALP scores for each of the operating nuclear power plants is presented in Attachment 2.

2.6 Analysis of 12 Nuclear Power Facilities

To obtain a better understanding of how low-level radioactive wastes were being managed at nuclear power facilities and to gauge whether nuclear power plants were in compliance with all applicable requirements,12 nuclear power plants were randomly selected on a stratified basis to represent the distribution of reactors by NRC Region and reactor design for further study. Exhibit 8 presents the 12 nuclear power facilities selected for further analysis.

EXHIBIT 8

Identification of Nuclear Power Facilities Selected for Analysis (Sorted by NRC Region and Construction Type)

Unit	Operating Utility	State	Docket #	NRC Region	Construction Type	Lic. Mwt	Lic. Number
Indian Point 3	Consolidated Edison Co.	NY	050-00286	I	PWR-DRYAMB	3025	DPR-64
Peach Bottom 3	PECO Energy Co.	PA	050-00278	I	BWR-MARK1	3458	DPR-56
Salem 1	Public Service Electic & Gas Co.	DE	050-00272	I	PWR-DRYAMB	3411	DPR-70
Edwin I. Hatch 2	Southern Nuclear Operating Co.	GA	050-00366	II	BWR-MARK1	2558	NPF-5
North Anna 1	Virginia Electric & Power Co.	VA	050-00338	II	PWR-DRYSUB	2893	NPF-4
Summer	South Carolina Electic & Gas Co.	SC	050-00395	II	PWR-DRYAMB	2900	NPF-12
Watts Bar 1	Tennessee Valley Authority	TN	050-00390	II	PWR-ICECND	3411	NPF-90
Fermi 2	Detroit Edison Co.	OH	050-00341	III	BWR-MARK1	3430	NPF-43
Palisades	Consumers Power Co.	MI	050-00255	III	PWR-DRYAMB	2530	DPR-20
Callaway	Union Electric Co.	MO	050-00483	IV	PWR-DRYAMB	3565	NPF-30
Cooper	Nebraska Public Power District	NE	050-00298	IV	BWR-MARK1	2381	DPR-46
Fort Calhoun	Omaha Public Power District	NE	050-00285	IV	PWR-DRYAMB	1500	DPR-40

Key for Construction Types:

PWR: Pressurized-Water Reactor; BWR: Boiling-Water Reactor; DRYAMB: Dry, Ambient Pressure; DRYSUB: Dry, Subatmospheric; ICECND: Wet, Ice Condenser; MARK 1: Wet, Mark I.

As shown in Exhibit 8, three facilities were selected from NRC Regions I and IV, four facilities from NRC Region II, and two facilities from NRC Region III. Exhibit 8 also shows that of the 12 reactors, four reactors were boiling-water reactors and eight reactors were pressurized-water reactors. It should be noted that this distribution approximates the total distribution between pressurized-water reactors and boiling-water reactors (see Exhibit 1).

2.6.1 Review of NRC Operating Licenses

Copies of the NRC operating license for each of the selected facilities were obtained from the NRC's Public Document Room. These licenses were reviewed to identify if any of the licenses contained conditions (or requirements) concerning the on-site management (treatment and storage) of low-level radioactive waste at the plants. Based on this review, it was observed that all of the licenses contained the following general statements (or slight variant with same effect):

- "This license shall be deemed to contain and is subject to the conditions specified in the commission's regulations set forth in 10 CFR Chapter I and is subject to all applicable provisions of the Act and to the rules, regulations, and orders of the Commission now or hereafter in effect, and is subject to the additional conditions specified or incorporated below."

- "The Technical Specifications contained in Appendix A and the Environmental Protection Plan contained in Appendix B, both of which are attached here to, are hereby incorporated in accordance with the Technical Specifications and the Environmental Protection Plan."

However, as summarized below, only a few of the licenses had specific conditions:

- **Cooper** (NRC Docket No. 50-0298) – "The licensee shall, for the operation not later than April 30, 1975, modify the liquid and gaseous radiological effluent handling systems in accordance with the systems described in Amendment 18 to the Final Safety Analysis Report." (2)(D).

- **Summer** (NRC Docket No. 50-0395) – "<u>Solid Radioactive Waste Treatment System</u> (Section 11.2.3, SSER 4), SCE&G shall not ship "wet" solid wastes from the facility until the NRC staff has reviewed and approved the process control program for the cement solidification system." (2)(c)(20).

- **North Anna** (NRC Docket No.50-0338) – "If Virginia Electric and Power Company plans to remove or to make significant changes in the normal operation of equipment that controls the amount of radioactivity in effluents from the North Anna Station, the Commission shall be notified in writing regardless of whether the change affects the amounts of radioactivity in the effluent." (2)(D)(2)(e).

In addition, as discussed earlier in Section 2.4.1, the Technical Specifications detail the operation of the plant and the Environmental Protection Plan provides for the protection of the non-radiological environment. Specifically, the Technical Specifications cover:

(1) Use and Application
(2) Safety Limits
(3) Limiting Conditions for Operating (LCO) Applicability
  -- reactivity control systems
  -- power distribution limits
  -- instrumentation
  -- reactor coolant system
  -- emergency cooling system
  -- containment system
  -- plant systems
  -- electrical power systems
  -- refueling operations
(4) Design Features
  -- site
  -- reactor core
  -- fuel storage
(5) Administrative Controls.

The Environmental Protection Plan ensures that the plant is operated in an environmental acceptable manner in accordance with the plant's Final Environmental Statement and other federal, state, and local requirements for environmental protection. Neither or these two appendices outlined specific low-level radioactive waste management requirements.

2.6.2 Review of Final Safety Analysis Reports (FSARS)

As discussed above in Section 2.4.1, the Final Safety Analysis Report (FSAR) is the principal document in which the applicant provides the information needed by the NRC to determine if the applicant has designed and analyzed the plant in sufficient detail for the NRC to conclude that the plant can be built and operated safely. Chapter 11 of the FSAR, is where the applicant details how (and where) radioactive liquids, gases, and solid wastes are going to be managed on-site (treatment and storage).

Copies of the FSARs for each of the 12 study facilities were obtained from the NRC's public document room and the relevant sections of each FSAR were reviewed to identify how the liquid, gaseous, and solid radioactive wastes were being managed at the sites. Excerpts of the relevant sections of the FSARs for each of the 12 study facilities are presented below in Sections 2.6.2.1 through 2.6.2.12.

2.6.2.1 Indian Point 3

A. WASTE DISPOSAL SYSTEM - DESIGN BASES

Control of Releases of Radioactivity to the Environment

Criterion: The facility design shall include those means necessary to maintain control over the plant radioactive effluents, whether gaseous, liquid, or solid. Appropriate holdup capacity shall be provided for retention of gaseous, liquid, or solid effluents, particularly where unfavorable environmental conditions can be expected to require operational limitations upon the release of radioactive effluents to the environment. In all cases, the design for radioactivity control must be justified (a) on the basis of 10 CFR 20 requirements, for normal operations and for any transient situation that might reasonably be anticipated to occur and (b) on the basis of 10 CFR 100 dosage level guidelines for potential reactor accidents of exceedingly low probability of occurrence (GDC 70).

Liquid, gaseous, and solid waste disposal facilities are designed so that discharge of effluents and off-site shipments are in accordance with applicable governmental regulations.

Radioactive fluids entering the Waste Disposal System are collected in sumps and tanks until determination of subsequent treatment can be made. They are sampled and analyzed to determine the quantity of radioactivity, with an isotopic breakdown if necessary. Before any attempt is made to discharge radioactive waste, they are processed as required and then released under controlled conditions. The system design and operation are characteristically directed toward minimizing releases to unrestricted areas. Discharge streams are appropriately monitored and safety features are incorporated to preclude releases in excess of the limits of 10 CFR 20.

The bulk of the radioactive liquids discharged from the Reactor Coolant System are processed and retained inside the plant by the Chemical and Volume Control System recycle train. This minimizes liquid input to the Waste Disposal System which processes relatively small quantities of generally low-activity level wastes. The processed water from waste disposal, from which most of the radioactive material has been removed, is discharged through a monitored line into the circulating water discharge.

Radioactive gases are pumped by compressors through a manifold to one of the gas decay tanks where they are held for a suitable period of time to decay. Cover gases in the nitrogen blanketing system are re-used to minimize gaseous wastes. During normal operation, gases are discharged intermittently at a controlled rate from these tanks through the monitored plant vent. The system is provided with discharge controls so that the release of radioactive effluents to the atmosphere is controlled within the limits set in the Technical Specifications.

The spent resins from the demineralizers, the filter cartridges and the concentrates from the evaporators are packaged and stored on-site until shipment off-site for disposal. Suitable containers are used to package these solids at the highest practical concentrations to minimize the number of containers shipped for burial.

All solid waste is placed in suitable containers and stored on-site until shipment off-site is made for disposal.

B. OVERALL SYSTEM DESIGN AND OPERATION

The Waste Disposal System collects and processes all potentially radioactive primary plant wastes for removal from the plant site within limitations established by applicable governmental regulations. Fluid wastes are sampled and analyzed to determine the quantity of radioactivity, with an isotropic breakdown if necessary, before any attempt is made to discharge them and they are then released under controlled conditions. A radiation monitor is provided to maintain surveillance over the release operation, but the permanent record of activity releases is provided by radiochemical analysis of known quantities of waste. The system is capable of processing all wastes generated during continuous operation of the primary system assuming that fission products corresponding to defects in one percent of the fuel cladding, escape into the reactor coolant.

As secondary functions, system components supply hydrogen and nitrogen to primary system components as required during normal operation, and provide facilities to transfer fluids from inside the containment to other systems outside the containment.

C. SYSTEM DESCRIPTION

1. Liquid Processing

During normal plant operation the Waste Disposal System processes liquids from the following sources:

a) Equipment drains and leaks
b) Radioactive chemical laboratory drains
c) Decontamination drains
d) Demineralizer regeneration
e) Floor drains

The system also collects and transfers liquid drained from the following sources directly to the Chemical and Volume Control System for processing:

a) Reactor coolant loops
b) Pressurizer relief tank
c) Reactor coolant pump secondary seals
d) Excess letdown during startup
e) Accumulators
f) Valve and reactor vessel flange leakoffs

The valve and reactor flange leakoff liquids flow to the reactor coolant drain tank and are discharged directly to the CVCS holdup tanks by the reactor coolant drain pumps which are operated automatically by a level controller in the tank. These pumps also return water from the refueling canal and cavity to the refueling water storage tank.

Where plant layout permits, waste liquids drain to the waste holdup tank by gravity flow. Other waste liquids including floor drains drain to the sump tank and are discharged to the waste holdup tank by pumps operated automatically by a level controller in the tank.

If preliminary analysis by sampling indicates that the liquid is suitable for discharge, it is pumped from the waste holdup tank to the waste condensate tanks where its activity can be determined for record by isolating, sampling and analyzing before it is discharged through the radiation monitor to the condenser circulating water.

Liquids requiring cleanup before release are processed in batches by the waste evaporator. The concentrated bottoms are discharged to the drumming room where they are packaged and stored until removal to a burial facility. The condensate is routed to one of two waste condensate tanks. When one tank is filled, it is isolated and sampled for analysis while the second tank is in service. If analysis confirms the activity level is suitable for discharge, the condensate is pumped through a flow meter and a radiation monitor to the condenser circulating water discharge. Otherwise it is returned to the waste holdup tank for reprocessing. Although the radiochemical analysis forms the basis for recording activity releases, the radiation monitor provides surveillance over the operation by preventing the discharge valve from opening if the liquid activity level exceeds that which can be safely discharged.

Sampling of the condenser inlet water and discharge water system is done continuously.

2. <u>Gas Processing</u>

During plant operations, gaseous wastes will originate from:

a) Degassing reactor coolant and purging the volume control tank

b) Displacement of cover gases as liquid accumulates in various tanks

c) Equipment purging

d) Sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases.

During normal operation the Waste Disposal System supplies nitrogen and hydrogen from standard cylinders to primary plant components. Two headers are provided, one for operation and one for backup. The pressure regulator in the operating header is set for 100 psig discharge and that in the backup header at 90 psig. When the operating header is exhausted, its discharge pressure will fall below 100 psig and an alarm will alert the operator. The second tank will come into service automatically at 90 psig to ensure a continuous supply of gas. After the exhausted header has been replaced, the operator manually sets the operating pressure back to 100 psig and the backup pressure at 90 psig. This operation is identical for both the nitrogen supply and the hydrogen supply.

Most of the gas received by the Waste Disposal System during normal operation is cover gas displaced from the Chemical and Volume Control System holdup tanks as they fill with liquid. Since this gas must be replaced when the tanks are emptied during processing, facilities are provided to return gas from the decay tanks to the holdup tanks. A backup supply from the nitrogen header is provided for makeup if return flow from the gas decay tanks is not available. Since the hydrogen concentration may exceed the combustible limit during this type of operation, components discharging to the vent header system are restricted to those containing no air or aerated liquids and the vent header itself is designed to operate at a slight positive pressure (0.5 psig minimum to 2.0 psig maximum) to prevent in-leakage. On the other hand, out-leakage from the system is minimized by using Saunders patent diaphragm valves, bellows seals, self contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

Gases vented to the vent header flow to the waste gas compressor suction header. One of the two compressors is in continuous operation with the second unit instrumented to act as backup for peak load conditions. From the compressors, gas flows to one of the four large gas decay tanks. The control arrangement on the gas decay tank inlet header allows the operator to place one large tank in service and to select a second large tank for backup. When the tank in service becomes pressurized to 110 psig, a pressure transmitter automatically opens the inlet valve to the backup tank, closes the inlet valve to the filled tank, and sounds an alarm to alert the operator of this event so that he may select a new backup tank. Pressure indicators are supplied to aid the operator in selecting the backup tank.

Gas held in the decay tanks can either be returned to the Chemical and Volume Control System holdup tanks, or discharged to the atmosphere if the activity concentration is suitable for release. Generally, the last tank to receive gas will be the first tank emptied back to the holdup tanks in order to permit the maximum decay time before releasing gas to the environment. However, the header arrangement at the tank inlet gives the operator freedom to fill, reuse or discharge gas to the environment simultaneously without restriction by operation of the other tanks.

Six additional small gas decay tanks are supplied for use during degassing of the reactor coolant prior to a cold shutdown. The reactor coolant fission gas activity inventory is distributed equally among the six tanks through a common inlet header. With this arrangement assuming 1% defective fuel rods the activity inventory in any one tank will be less than 2.0×10^4 curies of equivalent Xe-133 with this arrangement.

A radiation monitor in the sample line to the gas analyzer checks the gas decay tank activity inventory each time a sample is taken for hydrogen-oxygen analysis. An alarm warns the operator when the inventory limit is approached so that he may place another tank in service.

Before a tank can be emptied to the environment, its contents must be sampled and analyzed to verify sufficient decay and to provide a record of the activity to be released, and only then discharged to the plant vent at a controlled rate through a radiation monitor in the Event. Samples are taken manually by opening the isolation valve to the gas analyzer sample line and permitting gas to flow to the gas analyzer where it can be collected in one of the Sampling System gas sample vessels. After sampling, the isolation valve is closed. During release a trip valve in the discharge line is closed automatically by a high activity level indication in the plant vent.

During operation, gas samples are drawn periodically from tanks discharging to the waste gas vent header as well as from the particular large gas decay tank being filled at the time, and automatically analyzed to determine their hydrogen and oxygen content. The hydrogen analysis is for surveillance since the concentration range will vary considerably from tank to tank. There should be no significant oxygen content in any of the tanks, and an alarm will warn the operator if any sample shows 2% by volume of oxygen. This allows him time to isolate the tank before the combustible limit is reached. Another tank is placed in service while the operator locates and eliminates the source of oxygen. Discharged gases are released from the plant vent and diluted in the atmosphere due to the turbulence in the wake of the containment building in addition to the effects of normal dispersion.

3. Solids Processing

The Waste Disposal System is designed to package all solid wastes in standard 55 gallon drums for removal to burial facilities. Concentrates from the waste evaporator will be pumped into a battery of 6 drums previously filled with a mixture of vermiculite and cement. This type of operation is similar to that successfully used over the past few years at Brookhaven National Laboratories. After filling, the drums are moved to a shielded storage area by a bridge and trolley crane until a sufficient number have accumulated for shipment. The same crane is then used to place the drums on the carrier for removal to a burial site. Maximum dose rate for unshielded drums is 1 R/hr at one meter. Lead shielding is provided for each drum to reduce the dose rate in work areas to 1mR/hr at a one meter range.

Spent resins will be packaged in a similar manner. Normally resin will be stored in the spent resin storage tank for a period of 1 to 6 months for decay. Resin is removed from in the storage tanks first by bubbling nitrogen through the tank to agitate the resin and then pumping water through the tank at a controlled rate to sluice the slurry to the drumming room. There it is received in a battery of 30 gallon containers enclosed in lead shielding approximately a 55 gallon drum in size. The slurry will enter the 30 gallon drum and be de-watered by an internal screen designed to retain the resin. Sluice water returns to the waste holdup tank via the sump tank. These drums are handled in a fashion identical to the concentrates drums. Maximum dose rate from a 55 gallon sizes resin container is 1R/hr at one meter. The same lead shielding used around the concentrates drums also reduces dose rates to 1mR/hr at a one meter range for this container. The basis for all dose rate calculations is one cycle of operation with one percent defective fuel.

Miscellaneous solid wastes, such as paper, rags, and glassware, are compressed into 55 gallon drums by a hydraulically operated bailer located in the drumming room. Filled drums are stored in a shielded area in the drumming room.

D. COMPONENTS

Waste Disposal System components are located in the auxiliary building except for the reactor coolant drain tank which is in the containment and the waste holdup tank which is in the liquid holdup tank vault.

Regenerant Tank

The regenerant tank is austenitic stainless steel that allows the facility to batch caustic used to regenerate anion exchange resins.

Chemical Drain Tank

The chemical drain tank is a vertical cylinder of austenitic stainless steel and collects drainage from the hot section of the chemistry laboratory. After analysis, the tank contents are pumped to the waste holdup tanks or to the waste condensate tanks.

Reactor Coolant Drain Tank

The reactor coolant drain tank is a horizontal cylinder with spherically dished heads. The tank is all welded austenitic stainless steel. This tank serves as a drain surge for the Reactor Coolant System and other equipment located inside the reactor containment.

Waste Holdup Tank

The waste holdup tank is the central collection point for radioactive liquid waste. The tank is stainless steel of welded construction.

Sump Tank and Pumps

The sump tank serves as a collecting point for waste discharged to the basement level drain header. It is located at the lowest point in the auxiliary building. All floor drains enter this tank through a loop seal to prevent back flow of gas from the tank. Two horizontal centrifugal pumps transfer liquid waste to the waste holdup tank. All wetted parts of the pumps are stainless steel. The tank is all welded austenitic stainless steel.

Spent Resin Storage Tank

The spent resin storage tank retains resin discharged from the primary plant demineralizers. Normally, resins are stored in the tank from 1 to 6 months for decay of short-lived isotopes and then the tank is emptied. However, the contents can be removed at any time, if sufficient shielding is provided for the spent resin shipping vessel. A layer of water is maintained over the resin surface as a precaution against resin degradation due to heat generation by decaying fission. Resin is removed from the tank by first backflushing with nitrogen to loosen the resin bed and then flushing the resin out with water entering the bottom of the tank. The tank is all welded austenitic stainless steel.

Gas Decay Tanks

Four large and six small welded carbon steel tanks are provided to contain compressed waste gases (hydrogen, nitrogen, and fission gases). Afer a period of radioactive decay, these gases may be released at a controlled rate to the atmosphere through the plant vent. All discharges to the atmosphere will be monitored.

Compressors

Two compressors are provided for continuous removal of gases from equipment discharging to the plant vent header. These compressors are of the water-sealed centrifugal displacement type. Operation of the compressors is automatically controlled by radioactive waste gas vent header pressure. Construction is carbon steel. A mechanical seal is provided to maintain outleakage of compressor seal water at a negligible level.

Waste Evaporator Package

The evaporator concentrates dissolved and suspended solids in the liquid wastes. It consists of a batch tank, concentrator, distillate tank, an reagent tank, circulating pumps and control panel.

Surfaces exposed to radioactive liquids are austenitic stainless steel except for the heat transfer surfaces which are admiralty metal.

Waste Condensate Tanks

Two tanks collect waste evaporator condensate. The contents are sampled and analyzed for radioactivity and for chemical waste before discharge. The condensate is transferred by one of two waste condensate pumps to the waste holdup tank if the activity is high or to the condenser circulating water if the activity is sufficiently low. These tanks are constructed of all-welded stainless steel.

Bailer

A hydraulically operated bailer is used to pack compressible solid wastes into 55 gallon drums. The bailer is operated manually from a local station and is supplied with a dust shroud to prevent escape of radioactive particulate matter. The shroud vents to the building exhaust system.

Nitrogen Manifold

Nitrogen, used as cover gas in the vapor space of various components is supplied from a dual manifold. A pressure controller, which automatically switches from one manifold to the other, assures a continuous supply of gas.

Hydrogen Manifold

Hydrogen is supplied to the volume control tank to maintain the hydrogen concentration in the reactor coolant. The hydrogen is supplied from a dual manifold. A pressure controller, which automatically switches from one manifold to the other, assures a continuous supply of gas.

Gas Analyzer

An automatic gas analyzer with a nominal one hour recycle time is provided to monitor the concentrations of oxygen and hydrogen in the cover gas of tanks discharging to the radiogas vent header. Upon indication of a high oxygen level, an alarm sounds to alert the operator.

2.6.2.2 Peach Bottom 3

A. RADIOACTIVE WASTE SYSTEMS

SUMMARY DESCRIPTION

The radioactive waste systems are designed to furnish safe processing and disposal of all potentially radioactive wastes generated during plant operation. The radwaste systems consist of three basic systems:

1. Liquid radwaste system.
2. Solid radwaste system.
3. Gaseous radwaste system.

The liquid and solid wastes from both Units 2 and 3 are routed to a common radwaste building for collection, treatment, sampling, and disposal. Packaged solid wastes and reusable radioactive material may be temporarily stored in the radwaste on-site storage facility. Gaseous wastes are processed and routed to a common high stack for dilution and dispersion in the atmosphere.

The liquid and gaseous radwaste systems are designed to reduce the activity in the liquid and gaseous wastes such that the concentrations in routine discharges are less than the applicable regulatory limits. The liquid and gaseous effluents are continuously monitored and the discharge is stopped if the effluent concentrations exceed predetermined limits.

B. LIQUID RADWASTE SYSTEM

Power Generation Objective

The power generation objective of the liquid radwaste system is to collect, treat, and process for re-use or disposal all potentially radioactive liquid wastes in a controlled manner in compliance with the established regulatory requirements.

Power Generation Design Basis

1. The system has the capacity and capability to process the anticipated quantities of liquid wastes without impairing operation or availability of the plant.

2. The system has the capability to process the liquid waste such that a majority of liquid can be re-used within the plant.

3. The system is designed such that liquid discharge concentrations always are less than 10 CFR 20 limits.

Safety Design Basis

The liquid radwaste system prevents the inadvertent release of significant quantities of liquid radioactive material from the restricted area of the plant which could result in radiation exposures to the public in excess of the limits specified in 10 CFR 100.

Description

The liquid radwaste system collects, processes, stores, monitors, and disposes of all normally and potentially radioactive aqueous liquid wastes from both Units 2 and 3. Wastes are collected in sumps and drain tanks, and then transferred to the tanks in the radwaste building for treatment, storage, monitoring and disposal.

The liquid radwaste system is designed to collect various types of liquid wastes separately so that each type of waste can be processed by those methods most appropriate to that type. Liquid wastes are processed on a batch basis, and each batch is sampled to determine that all discharge requirements are met prior to release from the waste system.

Processed aqueous liquid wastes may be returned to the Condensate system for plant re-use or discharged to the environs after analysis and dilution with condenser circulating water. Under unusual circumstances, packaging of liquid wastes for off-site disposal is also possible.

Those batches in which the conductivity is low are routed to the condensate storage tank after processing for plant re-use. Those batches in which radioactivity concentrations are sufficiently low as to allow disposal to the environs and which have a higher conductivity than suitable for re-use in the plant (yet still relatively low on an absolute scale, i.e., above about 1 mho/cm) are released into the discharge canal. A discharge orifice is used to provide good mixing with condenser effluent circulating water from Units 2 and 3 in order to achieve a low concentration before the cooling water is returned to Conowingo Pond.

Radioactive aqueous liquids having a conductivity higher than suitable for re-use in the plant and a radioactivity concentration higher than can be safely released to the environment are processed for shipment and off-site disposal.

The liquid radwaste system was designed based on a reactor coolant activity corresponding to the maximum expected failed fuel condition (equivalent to a stack release of 100,000 μCi/sec after 30-min holdup). The levels of radioactivity in effluents to unrestricted areas are expected to be as low as practicable as defined in Appendix I to 10 CFR 50.

There are four basic aqueous liquid collection subsystems and an environment discharge subsystem comprising the liquid radwaste system. the collection subsystems are: (1) the equipment drain subsystem for low conductivity wastes (high purity water), (2) the floor drain subsystem for higher conductivity wastes, (3) the chemical drain subsystem for solution wastes and (4) the laundry drain subsystem for cleaning agent wastes.

Drains and sumps are utilized for initial segregation of potentially radioactive wastes. Sump solutions are pumped to specific collection tanks. Additional pumps and piping, plus process equipment, instrumentation, controls, and auxiliaries necessary to process, store and recycle or dispose of the wastes constitute the major radwaste system equipment.

There are other drains, sumps, etc., in the plant, which do not handle potentially radioactive liquid and are not a part of this system. This equipment is used in the collection and disposal of non-radioactive wastes from equipment or areas which are not radioactive or subject to radiological control.

Tanks, equipment, and piping which contain liquid radioactive wastes are enclosed within radwaste areas in buildings or tunnels and are shielded where required to permit operation, inspection and maintenance with acceptable personnel exposures. These areas are drained to sumps which return the liquid to the radwaste system. The main components of the liquid radwaste system are located in the radwaste building.

Collection Subsystems

Equipment Drain Subsystem for Low Conductivity Radioactive Waste

Low conductivity aqueous liquid wastes (high purity water) from piping and equipment drains are selectively collected in sumps.

These wastes are automatically pumped to the 21,000-gal floor drain collector tank on a batch basis when a sump high level set point is reached. In addition, liquid wastes are occasionally transferred to the waste collector tank from the fuel pool systems, the RHRS's, the reactor cleanup systems, and the floor drain system (to reclaim high purity water).

A 75,000-gal waste surge tank is located in the radwaste building and will provide surge capacity for infrequently occurring large volumes of liquid wastes, such as those produced during startup of a unit. Such water can be transferred to either the waste collector tank or the waste surge tank from the RHRS, the fuel pool, or the reactor clean-up system of either unit.

Low conductivity wastes collected in the waste collector tank (and waste surge tank) are processed on a batch basis through the waste collector filter and mixed bed demineralizer and then collected in one of the two waste sample tanks (25,000 gal each). Radioactive materials are most efficiently removed from the waste stream by this combination of filtration for removal of insoluble matter and of ion-exchange for removal of soluble matter.

From a waste sample tank, wastes are normally returned to the condensate storage tank for plant re-use. A recycle routing allows the return of high conductivity wastes (> μmho) or water of excessively high radioactivity concentration (>3 x 10^{-3} μCi/cc) to the waste collector tank or waste surge tank, for additional processing through the filter and demineralizer. Wastes from either waste sample tank may also be discharged to the environment or shipped off-site.

Floor Drain Subsystem for Higher Conductivity Radioactive Waste

Aqueous wastes of moderate to high conductivity and generally low radioactive concentrations (low purity water) mainly from floor drains, are selectively collected in sumps.

These wastes are automatically pumped to the 21,000-gal floor drain collector tank on a batch basis when a sump high level set point is reached. The floor drain collector tank also collects between 500 gal (normal) and 4,500 gal (maximum) of neutralized wastes on an average daily basis from the chemical waste tank and a small infrequent quantity of liquid waste from the two condensate and refueling water storage tank dike sumps.

A 75,000-gal floor drain surge tank is located in the radwaste building. This tank provides surge capacity for infrequent large volumes of liquid occurring during special plant operations such as equipment decontamination, etc.

These high conductivity wastes with generally low radioactivity content are processed through a pressure-precoat type filter and a mixed bed demineralizer, and then directed tot he waste collector tank for further processing for plant re-use. during periods of high input rates to the equipment drain system, the floor drain wastes can be directed from the floor drain demineralizer to the 21,000-gal floor drain sample tank. After these processed wastes are sampled and analyzed, they can be discharged to the environment through the circulating water discharge canal at a controlled rate as described below or pumped to either condensate storage tank if the water quality meets the condensate storage tank water standards. Wastes from the floor drain sample tank may be returned to either the floor drain collector or to the waste collector tank via the crosstie for further processing or pumped to either condensate storage tank if the water quality meets the condensate storage tank water standards.

The volume of waste processed through the floor drain system will average approximately 16,000 gal/day during normal operation and 34,000 gal/day during periods of maximum waste accumulation such as during maintenance operations.

Floor drains from the centrifuge area and the drumming area in the radwaste building lead to the conveyor sump (200-gal capacity) which acts as a settling basin for any solids that may be carried in the liquid wastes. Liquid from the conveyor sump is automatically pumped on a high liquid level signal to the waste sludge tank which is used to collect liquids with high suspended solids. Wastes from the sludge tank are later centrifuged to separate the liquid, which is returned to the waste collected tank, from the solid which is drummed for off-site disposal. Settled solids from the conveyor sump are drummed and shipped off-site as needed.

Chemical Waste Subsystem for Radioactive Chemical Wastes

Radioactive high conductivity chemical wastes such as laboratory drains (routine) and chemical decontamination solutions (infrequent) are collected in the 5,000-gal chemical waste tank in the radwaste building. These chemical wastes are of such high conductivity as to preclude treatment by ion-exchange. The radioactivity concentrations are variable and substantially affected by the use of decontamination solutions and by the amount of fission product radioactivity present. The wastes are adjusted to a pH between 7.0 to 9.0 before being transferred to the floor drain collector tank on a batch basis for filtration and dilution along with floor drain wastes. Normally only laboratory wastes are present. When non-detergent decontamination solutions are used, they follow the same routing. An average of approximately 500 gal of chemical waste per day is expected normally, and about 4,500 gal during periods of maximum accumulation.

Laundry Drain Subsystem for Radioactive Liquid Waste Containing Chemical Cleaning Agents

Liquid waste containing detergents or similar cleaning agents or chemicals from the laundry drains, cask washdown, and personnel decontamination station drains may be collected separately in one of two 1,000-gallon laundry drain tanks. One of the tanks may be used for collection while the other is used primarily as a collection and hold point for sampling prior to discharge. Processing may be through the laundry drain filter or through temporary processing equipment specifically configured for treatment of the liquid waste stream, the Chemical/Oily Waste Cleanup Subsystem.

Waste waters containing oils, cleaning agents or chemicals may also be collected in designated drums located in areas around the plant where such wastes are generated. These drums of liquid are transported to the Radwaste Building for processing as required and release.

Processed liquids or waste water which is acceptable for release without processing are transferred to one of the two laundry drain tanks and isolated. Each isolated batch for discharge is sampled during recirculation. If acceptable for release, it is then discharged to the environment through the laundry drain filter. Wastes containing cleaning agents can be shipped off-site for disposal if analysis indicates high radioactive content. This, however, is expected to be very unusual.

The volume of waste in this classification is expected to average approximately 900 gal/day under normal conditions and 1,800 gal/day during periods of maximum waste accumulation, e.g., during refueling and maintenance. The activity concentration of these wastes is normally quite low. The maximum concentration is less than 10^{-4} μCi/cc.

Non-Aqueous Liquid Radwastes

Oil contaminated with radioactivity or other non-aqueous radioactive liquid wastes are collected at their source and processed to produce an acceptable waste form which meets burial site requirements. The processed waste is placed in an approved containers for shipment and disposal off-site in accordance with applicable regulations. Periodically, contaminated oil will be processed using vendor-supplied mobile equipment. None will be discharged to the environment. Batches of this type of waste are only occasionally produced.

Power Generation Evaluation

The liquid radwaste system collects, processes and discharges all potential radioactive liquids produced in Units 2 and 3. Prior to discharge, wastes are sampled in batches.

A radiation monitor is provided to give a continuous indication and record of the radioactivity in the only line used to release radioactive material to the environment.

The liquid radwaste processing equipment is located within concrete cells, or rooms, in concrete buildings. The concrete enclosures provide biological shielding and also serve as a secondary confinement barrier for radwaste liquids.

C. GASEOUS RADWASTE SYSTEM

Power Generation Objective (Common)

The power generation objectives of the gaseous radwaste system is to collect, process, monitor, and discharge potentially radioactive gases generated by the power conversion systems during operation.

Power Generation Design Basis

1. The gaseous radwaste system processes gaseous wastes without affecting the operation or availability of the station.

2. Gaseous wastes are released in a controlled manner to the environs such that, during planned operations, on-site and off-site activity levels are within the limits of 10 CFR 20 and the dose guidelines of 10 CFR 50 Appendix I.

3. The gaseous radwaste system is designed with adequate safeguards for protection against the possible explosion hazard from the hydrogen and oxygen present due to the radiolytic decomposition of reactor water.

4. The gaseous radwaste system is designed with capacity and redundancy to accommodate all anticipated processing requirements of the plant during normal operation and anticipated operational occurrences.

5. The off-gas system is designed to maintain the concentration of hydrogen below flammable limits throughout most of the system.

6. Instrumentation is provided in the off-gas system to detect abnormal concentrations of hydrogen and other system malfunctions.

7. The off-gas system is designed to keep the exposure to plant personnel as low as reasonably achievable (ALARA) during normal operation and maintenance.

8. Design provisions are incorporated which preclude the uncontrolled release of radioactivity to the environment from the off-gas system as a result of operator error or single active component failure.

Safety Design Basis

1. The gaseous radwaste system prevents the inadvertent release of significant quantities of gaseous and particular radioactive material so that resulting radiation exposures are within the limits of 10 CFR 100.

2. The off-gas system design basis and maximum expected source terms are 100,000 and 60,000 uCi/sec., respectively, of radioactive noble gases after 30 minute delay.

3. Continuous monitoring is provided for all potential pathways of airborne radioactive release, with annunciation at levels lower than normal release limits.

4. The off-gas system is designed in accordance with the guidelines of Regulatory Guide 1.143 to the maximum extent practical.

Description

The gaseous radwaste system includes the subsystems that process and dispose of the gases from the main condenser air ejectors, the mechanical a vacuum pump, and the turbine steam packing exhauster condenser.

The condenser air removal system is utilized to establish a vacuum in the three main condenser sections and to maintain this vacuum during normal plant operation by removing non-condensible gases. The mechanical vacuum pump is used to establish initial vacuum or maintain partial vacuum when steam pressure is not adequate to operate the steam jet air ejector units.

The mechanical vacuum pump takes suction on the main condenser and discharges the non-condensible gases to a discharge pipe which provides approximately 4 minutes holdup time. This relatively short holdup time is sufficient because the pump is only in service during startup when the power level is below 5 percent and little or no radioactive gas is present.

The steam jet air ejectors are placed in service after a vacuum of approximately 25 inches of mercury (hg) is established by the mechanical vacuum pump and sufficient steam pressure is available.

Continuous radiation monitoring provides an indication of radioactive release from the off-gas system. The off-gas effluent radiation monitor and control system is used to monitor the condition of reactor fuel and alert operators to the fact that off-gas levels are increasing.

Air Ejector Subsystem

During normal operation, the air ejector off-gas is the major contributor to the activity in the plant off-gas release. The air ejector off-gases are non-condensibles from the main condenser. They consist essentially of hydrogen and oxygen formed in the reactor by radiolytic decomposition of water, activation gases, air in leakage to the turbine-condenser, water vapor, and a negligible volume of fission product gases.

Safety Evaluation

The air ejector subsystem, with its recombiner and adsorber bed, provides a minimum radioactive dose equivalent delay to a 89-hour holdup of the air ejector off-gases with an air in leakage of 24.2 scfm.

The main condenser off-gas system has been evaluated for reliability of operation during power generation. Based on this evaluation, certain equipment in the train is provided with full capacity standby capability.

All portions of the main condenser off-gas system are designed to withstand the effects of a hydrogen detonation without breach of the pressure boundary. Piping and components in the off-gas stream have been analyzed in accordance with the methodology described in Appendix C of ANSI/ANS-55.4-1979. This methodology has been demonstrated to be conservative by theoretical analysis and operating experience.

An analysis of a postulated rupture of the inlet to the adsorber bed has been performed in accordance with Standard Review Plan 11.3. The inlet concentration and adsorber inventories were based on the conservative release rate of 100 uCi/sec/mwt. The analysis assumes a ground level release and, using Regulatory Guide 1.98, meteorology shows that 70% of all the adsorber contained noble gas could be released before the SRP limit of 500 mrem is exceeded. Utilizing site specific meteorology, release of the entire bed contents would result in a site boundary does of 296 mrem which is below the SRP limit.

The air ejector off-gas system is monitored and controlled to ensure that the radiation dose limits at the site boundary, as prescribed by 10 CFR 20 are not exceeded. Continuous radiation monitors records the radiation level at the outlet of each main adsorber bed and alarm in the main control room on high radiation. Radiation levels in excess of the allowable instantaneous release rate cause alarms in the main control room to alert the operators of a malfunction so that they can take corrective action. Radiation monitors are also provided in the main stack to record the actual activity released from the stack.

The tall off-gas stack allows atmospheric dispersion of the effluent to reduce direct radiation exposure rates. Stack release rate limit calculations are discussed in Appendix E.

Shielding for the off-gas system equipment is provided to limit radiation doses to the values specified in 10 CFR 20.

D. SOLID RADWASTE SYSTEM

Power Generation Objective

The solid radwaste system collects, processes, temporarily stores, and prepares potentially radioactive solid wastes for off-site shipment and disposal.

A Process Control Program (PCP) has been established which will ensure suitability of packaged waste for shipment and burial in accordance with applicable State and Federal regulations. The PCP describes the methods and controls for processing and packaging solid radwaste. Any revision to the PCP requires review and approval.

Power Generation Design Basis

The solid radwaste system is designed to package radioactive solid wastes in high integrity containers (HICs) or other approved packages for off-site shipment and disposal in accordance with applicable regulations.

Description

The solid radwaste system consists of those systems and components which are used to condition and package wet process wastes so that the waste is suitable for transport and disposal. The system processes both wet and dry solid wastes; it is not used for spent fuel storage and shipment. Temporary storage capacity for packaged solid wastes is provided by the radwaste on-site storage facility.

Different methods are used for processing and packaging solid radioactive wastes, depending primarily upon the waste characteristics. The solid radwaste system includes the phase separators which serves an interface with the liquid radwaste processing system and the dewatering system. The dewatering system is the system used to dewater filter and demineralizer material to meet burial site and 10 CFR 61.56 requirements. High Integrity Containers (HICs) are the disposal package used when the waste classification requires that the waste meet stability requirements. Only HICs certified acceptable for use at the disposal facility to which the waste is destined are used.

Dry Active Wastes (DAW) are collected in sealed bags and loaded into a large container for transport to an off-site processor. Packaged dry wastes may be stored temporarily on-site to optimize shipping. Most of the dry wastes are not sufficiently radioactive to preclude manual handling. Most DAW are shipped to an off-site processor for further volume reduction prior to disposal. DAW which does not meet the criteria for processing by the off-site processor may be compacted into 55-gallon drums for direct shipment to a burial facility.

Shielded areas are provided for liner processing and temporary storage. Wet wastes are packaged semi-remotely to reduce radiation exposure (and possible contamination) to personnel. Packaged dewatered resins may be temporarily stored in shielded cells provided at the radwaste on-site storage facility.

Wet Solid Radwaste

Wet solid radwastes result from the processing of spent demineralizer resins (both bead and powdered) and spent filter material from the equipment drain and floor drain subsystems, and from the three (reactor, condensate, and fuel pool) water cleanup systems. The wastes are in the form of spent demineralizer resins and filter material water slurries which are collected in the four backwash receiving tanks or in the waste sludge tank. The slurries collected in the backwash receiving tanks is pumped on a batch basis to one of the corresponding phase separators.

The Condensate and Reactor Water Cleanup filter demineralizers are backwashed to their respective phase separators for collection and decay. The slurry is stagnant in the phase separator, allowing solids to settle so that clarified liquid may be decanted off the top. The process continues until a sufficient quantity of solids is collected for processing.

The radwaste filter demineralizers, radwaste deep bed demineralizers, and fuel pool filter demineralizers are backwashed to the Waste Sludge Tank. When a sufficient volume has been collected in the tank, its contents are then pumped to a condensate phase separator for further processing.

When sufficient volume has been collected in a phase separator, that phase separator is isolated and its contents recirculated to obtain a homogeneous slurry at the required solids concentration range. The slurry is then pumped to the dewatering system. The dewatering system is described in its NRC approved topical report.

Filled HICs may be stored inside of shielded cells located within the on-site storage facility. This facility is designed to allow for remote handling. Cell covers are installed subsequent to a storage or retrieval operation. Floor drains from each cell are routed to a collection tank for sampling and analysis prior to transfer to the non-radioactive sump for discharge, or if radioactive, for processing via a portable demineralizer or transfer to a mobile processing system. Normal discharge is made from the non-radioactive sump to the storm drain system after sample analysis and sump contents monitoring show acceptably clean water. The discharge valve is interlocked to a radiation monitor to prevent inadvertent discharge of contaminated liquids.

Dry Wastes

Dry active wastes (DAW), generated as a result of operation and maintenance activities, are collected throughout the radiologically controlled areas of the facility. Typical wastes of this type are air filters, cleaning rags, protective tape, paper and plastic coverings, discarded contaminated clothing, tools, equipment parts, and solid laboratory wastes. Most DAW have relatively low radioactive content and may be handled manually. DAW is collected from throughout the plant in closed bags and loaded into containers for shipment to an off-site processor for decontamination or further volume reduction prior to disposal. Elected items may be decontaminated on-site as practical for reuse or release as clean.

Packaged DAW is monitored as filled to assure control is maintained. DAW bags are loaded into SeaLand containers until a sufficient volume has been collected to fill the container for transport. Package dry wastes may also be stored in the dry waste storage area of the radwaste on-site storage facility.

The external dose rates of all shipment packages are controlled within the limits as set forth in 10 CFR 71, and the design and transportation of all waste are in accordance with 10 CFR 71 and the applicable regulations of the Department of Transportation.

The radwaste on-site storage facility is an interim storage facility designed to hold approximately 5 years of both dewatered and dry packaged solid radwaste. Storage of waste at this facility is in accordance with applicable published regulations.

Because the solid radioactive waste system is equipped to facilitate the packaging and storage of all types of materials in conjunction with other plant provisions and meet appropriate established regulations for off-site disposal, the system fulfills the power generation design basis.

The collection, packaging, and storage facilities are sufficient, in conjunction with other plant provisions for decontamination, shielding, and ventilation, to prevent an accidental release of radioactive solid wastes. Solid radwastes are shipped in approved containers.

2.6.2.3 Salem 1

A. LIQUID WASTE SYSTEM

The Liquid Waste System (LWS) provides controlled handling and disposal of liquid wastes generated during plant operation. The system is designed to minimize exposure to plant personnel and the general public, in accord with Nuclear Regulatory Commission (NRC) regulations.

Design Objectives

The design objectives of the LWS are the following:

1. Maintain annual activity releases within the limits specified in 10 CFR 20

2. Protect the public health and safety by maintaining radioactive releases as low as practicable

3. Collect radioactive and potentially radioactive liquid wastes

4. Provide processing of liquid wastes such that operation and availability of the stations are not limited

5. Assure that exposures to the public are maintained below the design objectives set by Appendix I to 10 CFR 50

The design criteria for the LWS are as follows:

The facility design shall include those means necessary to maintain control over the plant radioactive liquid effluents. Appropriate holdup capacity shall be provided for retention of liquid, particularly where unfavorable environmental conditions can be expected to require operational limitations upon the release of radioactive effluents to the environment. In all cases, the design for radioactivity control shall be justified (1) on the basis of 10 CFR 20 requirements, for both normal operations and for any transient situation that might reasonably be anticipated to occur and (2) on the basis of 10 CFR 100 dosage level guidelines for potential reactor accidents of exceedingly low probability of occurrence.

Liquid facilities are designed so that discharge of effluents and offsite shipments are in accordance with applicable governmental regulations.

Radioactive fluids entering the LWS are collected in tanks until determination of subsequent treatment can be made. They are sampled and analyzed to determine the quantity of radioactivity, with an isotopic breakdown if necessary. Liquid wastes are processed as required and then released under controlled conditions following isotopic analysis. The system design and operation are directed toward minimizing releases to unrestricted areas. Discharge streams are appropriately monitored and safety features are incorporated to preclude releases in excess of the limits of 10 CFR 20.

System Description

The bulk of the radioactive liquids discharged from the Reactor Coolant System (RCS) is processed and retained inside the plant by the Chemical and Volume Control System (CVCS) recycle train. This minimizes liquid input to the LWS which processes relatively small quantities of generally low activity level wastes. The processed water from waste disposal, from which most of the radioactive material has been removed, is discharged through a monitored line to the service water discharge header and then to the circulating water discharge.

During normal plant operation, the LWS processes liquids from the following sources:

1. Equipment drains and leaks
2. Radioactive chemical laboratory drains
3. Hot shower drains
4. Decontamination area drains
5. CVCS demineralizer regenerant solutions and spent resins
6. Sampling System

In addition, piping has been installed to direct potential fluid leakage from valves in the following systems to the LWS: Residual Heat Removal (RHR), Safety Injection (SIS), Containment Spray, CVCS, Sampling Systems. This design minimizes the spread of highly radioactive liquid throughout the plant in the event of postulated accidents.

The LWS also collects and transfers liquids from the following sources directly to the CVCS, to the waste holdup tanks, or back to the refueling water storage tank (depending on fluid content) for processing:

1. Reactor coolant loops
2. Pressurizer relief tank
3. Reactor coolant pump secondary seals
4. Excess letdown (during startup)
5. Accumulators
6. Valve and reactor vessel flange leakoffs
7. Refueling canal drains

These liquids flow to the reactor coolant drain tank and are discharged either directly to the CVCS holdup tanks or to the waste holdup tanks by the reactor coolant drain pumps which are operated automatically by a level controller in the tank. These pumps also return water from the refueling canal and cavity to the refueling water storage tank. There is one reactor coolant drain tank with two reactor coolant drain tank pumps located inside containment.

Where possible, waste liquids drain to the waste holdup tanks by gravity flow. Other waste liquids drain to the Auxiliary Building sump tank and are discharged to the waste holdup tanks by pumps operated automatically by a level controller for the Auxiliary Building sump tank.

With the exception of the shared pumps and tanks for the Laundry and Hot Shower Drains, the Chemical Drains, and the Portable Demineralizer, each unit has its own Liquid Waste Disposal System. The Laundry and Hot Shower Drain Tanks and the Chemical Drain Tank are pumped to one of the Waste Hold-up Tanks or the Waste Monitor Hold-up Tank of either unit.

When a Waste Hold-up or Waste Monitor Hold-up Tank is filled, it is isolated and sampled while another tank is in service. If analysis confirms that the activity level of the tank's contents is suitable for discharge, the tank's contents may be pumped through a flow meter and a radiation monitor to the Service Water System. Tanks requiring processing before releases are routed on a batch basis through a portable demineralizer. The effluent of the portable system is returned either to the Waste Monitor Hold-up Tanks or the CVCS Monitor Tanks to be sampled, analyzed, and either reprocessed or pumped through a flow meter and a radiation monitor to the Service Water System.

Although the Waste Monitor Hold-up or CVCS Monitor Tank analysis forms the basis for recording activity releases, the radiation monitor provides surveillance over the operation by closing the discharge valve if the liquid activity exceeds a preset value.

The system is capable of processing all liquid wastes generated during continuous operation of the primary system assuming that fission products escape to the reactor coolant by diffusion through defects in the cladding on one percent of the fuel rods.

At least two valves must be manually opened to permit discharge of liquid waste from the LWS. The control valve will trip closed on a high effluent radioactivity level signal.

The system is controlled from a central panel in the Auxiliary Building. Malfunction of the system is alarmed in the Auxiliary Building, and annunciated in the Control Room. All system equipment is located in the Auxiliary Building, except for the reactor coolant drain tank and drain tank pumps which are located in the reactor containment, and a 2-inch line from the drain tank pumps to the refueling water storage tank (RWST).

B. GASEOUS WASTE SYSTEM

The Gaseous Waste System (GWS) provides controlled handling and disposal of gaseous wastes generated during plant operations. The system also supplies hydrogen and nitrogen to primary systems' components as required during normal operations. The system is designed to minimize exposure to plant personnel and the general public, in accordance with Nuclear Regulatory Commission (NRC) regulations. In this section, the system is described and evaluated.

Design Objectives

Design objectives for the GWS are the following:

1. To provide sufficient capacity and storage to process and store the volume of gaseous effluent expected for a period of 45 days

2. To provide cover gas for the liquid holdup tanks

3. To assure that releases of radioactive gaseous wastes are kept as low as practicable

4. To maintain releases below the limits set by 10 CFR 20

5. To assure that exposures to the public are maintained below the design objective of 10 CFR 50 Appendix I

The design criteria for the GWS are as follows:

The facility design shall include those means necessary to maintain control over the plant radioactive gaseous effluents. Appropriate holdup capacity shall be provided for retention of gaseous effluents, particularly where unfavorable environmental conditions can be expected to require operational limitations upon the release of radioactive effluents to the environment. In all cases, the design for radioactivity control shall be justified (1) on the basis of 10 CFR 20 requirements, for both normal operations and for any transient situation that might reasonably be anticipated to occur and (2) on the basis of 10 CFR 100 dosage level guidelines for potential reactor accidents of exceedingly low probability of occurrence.

Gaseous waste facilities are designed so that discharge of effluents are in accordance with applicable governmental regulations.

Radioactive gases entering the GWS are collected in tanks to allow for decay and isotopic analysis. The system design and operation is directed toward minimizing releases to unrestricted areas. Discharge streams are appropriately monitored and safety features are incorporated to preclude releases in excess of the limits of 10 CFR 20.

Radioactive gases are pumped by compressors through a manifold to one of the gas decay tanks where they are held for a suitable period of time to allow for decay. Cover gases in the Nitrogen Blanketing System can be reused to minimize gaseous wastes. During normal operation, decayed gases are discharged intermittently at a controlled rate from these tanks through the monitored plant vent. The system is provided with discharge controls.

<u>System Description</u>

During plant operations, gaseous wastes will originate from the following:

1. Degassing reactor coolant discharge to the Chemical and Volume Control System (CVCS)

2. Displacement of cover gases as liquids accumulate in various tanks

3. Miscellaneous equipment vents and relief valves

4. Sampling operations and automatic gas analysis for hydrogen and oxygen in cover gases.

The GWS consists of two waste gas compressors and four waste decay tanks. During normal operation, the GWS supplies nitrogen to plant components. Two liquid nitrogen storage tanks, each with a self contained (ambient) vaporizer are supplied. One storage tank and its vaporizer is used at a time to supply the operating headers for both units. The pressure regulator in the operating header of each unit is set for 100 psig discharge. Each operating header is backed up by a nitrogen (gaseous) cylinder manifold with a pressure regulator set at 90 psig. When the operating header is below 100 psig, an alarm will alert the operator. The backup header will come into service automatically at 90 psig to assure a continuous supply of gas. After the operating header has been switched over to the standby liquid nitrogen storage tank, and the operating header pressure restored to 100 psig, the flow from the backup header will drop to zero. In addition to use as a backup nitrogen supply to the Waste Disposal System (WDS), the nitrogen (gaseous) cylinder manifold also supplies high pressure nitrogen gas for recharging accumulators. A hydrogen cylinder manifold is included in the Gaseous Waste Disposal System. It serves as a backup supply for hydrogen feed to the volume control tank. Normal feed is from the bulk hydrogen Control System.

Most of the gas received by the WDS during normal operation is cover gas displaced from the CVCS holdup tanks as they fill with liquid. Since this gas must be replaced when the tanks are emptied during processing, facilities are provided to return gas from the decay tanks to the holdup tanks. A backup supply from the nitrogen header is provided for makeup if return flow from the gas decay tanks is not available. To avoid the possibility of hydrogen combustion in the vent header system while gas is being displaced from holdup tanks to the vent header, components discharging to the vent header system are restricted to those containing no air or aerated liquids and the vent header itself is designed to operate at a slight positive pressure (0.5 psig minimum to 4.0 psig maximum) to prevent inleakage. Outleakage from the system is minimized with Saunders patent diaphragm valves, bellows seals, self-contained pressure regulators and soft-seated packless valves throughout the radioactive portions of the system.

Gases vented to the vent header flow to the waste gas compressor suction header. One of the two compressors is in continuous operation with the second unit instrumented to act as backup for peak load conditions or failure of the first unit. From the compressors, gas flows to one of four gas decay tanks. The control arrangement on the gas decay tank inlet header allows the operator to place one tank in service and to select one tank for backup. When the tank in service becomes pressurized to 92 psig, a pressure transmitter automatically closes the inlet valve to that tank, opens the inlet valve to the backup tank and sounds an alarm to alert the operator so he may select a new backup tank. Pressure indicators are provided to aid the operator in selecting the backup tank.

Gas held in the decay tanks can either be returned to the CVCS holdup tank or discharged to the atmosphere if it has decayed sufficiently for release. Generally, the last tank to receive gas will be the first tank emptied back to the holdup tanks which permits the maximum decay time before releasing gas to the environment. However, the header arrangement at the tank inlet gives the operator the option to fill, reuse or discharge gas to the environment simultaneously without restriction by operation of the other tanks.

During degassing of the reactor coolant prior to a cold shutdown, for example, it may be desirable to pump the gas purged from the volume control tank into a particular gas decay tank and isolate that tank for decay rather than reuse the gas in it. This is done merely by aligning the control to open the inlet valve to the desired tank and closing the outlet valve to the reuse header. Simultaneously, one of the other tanks can be opened to the reuse header if desired, while another is discharged to atmosphere.

Before a tank is discharged to the environment, it is sampled and analyzed to determine and record the activity to be released, and then discharged to the plant vent at a controlled rate, and monitored for gross activity.

During operation, gas samples are drawn automatically from the gas decay tanks and automatically analyzed to determine their hydrogen and oxygen content. There should be no significant oxygen content in any of the tanks, and an alarm will warn the operator if any sample shows 2 percent or higher by volume of oxygen. This allows time to take required action before the combustible limits of the hydrogen-oxygen mixtures are reached. Another tank is placed in service while the operator locates and eliminates the source of oxygen.

The system is controlled from a central panel in the Auxiliary Buildings. Malfunction of the system is alarmed in the Auxiliary Building, and annunciated in the Control Room. All system equipment is located in the Auxiliary Building.

C. SOLID RADWASTE SYSTEM

The Solid Radwaste System collects, processes, packages, and provides temporary storage for radioactive solid wastes due for offsite shipment and permanent disposal.

Design Objectives

1. To provide a means of collecting waste evaporator concentrates and spent demineralizer resins generated during plant operation.

2. To provide a means of mixing and solidifying waste evaporator concentrates, spent resins and expended filters in containers suitable for transfer from the plant site.

3. To provide a means of packaging low level contaminated solid wastes such as glasswear and clothing.

4. To provide a means of processing spent resins and packaging for offsite shipment.

The design criteria for the Solid Radwaste Treatment System are as follows:

The facility design shall include those means necessary to maintain control over the plant radioactive solid waste. Appropriate storage capacity shall be provided for retention of solid wastes. In all cases, the design for radioactivity control shall be justified (a) on the basis of 10 CFR 20 requirements, for both normal operations and for any transient situation that might reasonably be anticipated to occur and (b) on the basis of 10 CFR 100 dosage level guidelines for potential reactor accidents of exceedingly low probability of occurrence.

The solid waste facility is designed so that offsite shipments are in accordance with applicable governmental regulations.

The spent resins from the demineralizers, the filter cartridges and the concentrates from the evaporators are packaged and stored on site until shipment offsite for disposal.

System Design

The solid processing portion of the Waste Disposal System is designed to package all solid wastes for removal to volume reduction or burial facilities. All packaging shall meet DOT/NRC approval as applicable depending upon contents. Packages for burial will additionally conform to burial site facility criteria.

The resins are transferred to appropriate shipping containers for processing as necessary prior to transport.

Equipment Description

The Solid Radwaste System consists of components and subsystems described below.

Drumming Station

The drumming station is a remote controlled unit that automatically mixes evaporator bottoms concentrates or spent resins with cement in 55-gallon drums. The drumming station is attached to a shield wall which protects operational personnel from exposure to the operation.

Waste Compactor

A hydraulically-operated waste compactor is used to compress solid wastes into DOT/NRC approved packages as appropriate depending upon content.

Waste Processing Facility

The resin processing equipment is operated manually from a local control station on the appropriate shipping container. The processing is done within the Auxiliary Building to control the release of air and liquid to the environment. Activity levels of the contents are monitored to limit the doses during shipment.

Off-Site Volume Reduction

DAW is collected in Sea-vans and then shipped off-site for volume reduction processing by a licensed contractor. The volume-reduced DAW is placed into packages that will meet DOT/NRC approval and then shipped for disposal at a licensed burial site.

Packaging

Packaging is done in DOT/NRC approved packages, as appropriate, depending upon contents.

Storage Facilities

The storage areas shielded to protect personnel in accessible portions of the solid radwaste area. The shielding is designed to meet the requirements of 10 CFR 20.

Low-level radwaste can be stored in the Low-Level Radwaste Storage Facility (LLRSF) for up to 5 years if shipping to a Low-Level Radwaste Disposal Facility is denied. The LLRSF has been specifically designed in accordance with guidelines provided in Generic Letter 81-38.

Shipment

The average annual volumes of solid wastes (on a two unit basis) shipped from the Salem Generating Station are as follows:

Spent resins, filter sludges, evaporator bottoms	25 cubic meters
Dry compressible waste, contaminated equipment	100 cubic meters

The Process Control Program (PCP) has been approved by the Nuclear Regulatory Commission (NRC) which outlines the in-plant measures and controls to assure the suitability of radioactive waste products for transportation and/or disposal at a licensed burial site.

2.6.2.4 Edwin I. Hatch 2

A. LIQUID RADWASTE SYSTEM

The liquid radwaste system is designed to process and recycle the liquid waste collected to the extent practicable. During normal plant operation, the annual radiation doses to individuals from each reactor on the site, resulting from these routine liquid waste discharges, are below the guidelines set forth in 10 CFR 50, Appendix I. The design further ensures that short-term releases from the plant, resulting from equipment malfunctions or operational transients, are within the 10 CFR 20.1-20.601 (found in 10CFR published before January 1994) limits. Liquid effluents are continuously monitored and discharges are terminated if the effluents exceed preset radioactivity levels.

DESIGN BASES AND OBJECTIVES

1. Liquids that potentially contain radioactive materials are collected and processed in the radwaste system.

2. The liquid radwaste treatment system is designed to limit effluent releases during normal plant operation to concentrations below those specified in 10 CFR 20.1-20.601 (found in 10 CFR published before January 1994), and which result in doses to individuals below the as low as reasonably achievable (ALARA) guidelines set forth in 10 CFR 50, Appendix I.

3. The system has the capability to process the anticipated quantities of liquid wastes without impairing operation or availability of the plant during both normal and expected occurrence conditions.

4. The various types of liquid wastes are treated to recycle the maximum amount of water to the plant for reuse within the limitations of water inventory balance and reactor water quality specifications.

5. Portions of the system containing unprocessed wastes are designed and installed in accordance with American Society of Mechanical Engineers (ASME) Code, Section III, Class 3 requirements. Piping and valves to the exterior fill station are designed and installed in accordance with American National Standards Institute (ANSI) Standard B31.1. Replacement components may be procured in accordance with the requirements of Table 1 of Regulatory Guide 1.26, September 1974 (reference 2), and Table 1 of Regulatory Guide 1.143, October 1979 (reference 3).

6. The accidental release of radioactivity caused by a system gross equipment failure is limited so that the resulting radiation exposure of the public is within the annual exposure limit of 10 CFR 20.1-20.601 (found in 10 CFR published before January 1994).

SYSTEM DESCRIPTION

The liquid radwaste system collects, monitors, processes, stores, and disposes of radioactive liquid wastes.

- Piping and equipment drains carrying potentially radioactive wastes.
- Floor drain systems in controlled access areas which contain potentially radioactive wastes.
- Tanks and sumps used to collect potentially radioactive wastes.
- Tanks, sumps, piping, pumps, process equipment, instrumentation, and auxiliaries necessary to collect, process, store, and dispose of potentially radioactive wastes.

Equipment is selected, arranged, and shielded to permit operation, inspection, and maintenance with acceptable personnel exposures. For example, sumps, pumps, valves, and instruments which contain radioactivity are located in controlled access areas. Tanks and processing equipment that contain significant quantities of radioactive material are shielded. Operation of the radwaste system is essentially manual start, automatic stop.

Protection against accidental discharge is provided by instrumentation for detection and alarm of abnormal conditions and by procedural controls. The radwaste facility arrangement and the methods of waste processing provide a substantial degree of immobility of the wastes within the plant. These provisions ensure that, in the event of a failure of the liquid waste system equipment or errors in operation of the system, the potential for inadvertent release of liquids is small. Immobility of wastes is further accomplished by collecting solids on filters and demineralizer resins.

The liquid radwaste system is divided into several subsystems so that the liquid wastes from various sources can be kept segregated and processed separately. Cross connections between the subsystems provide additional flexibility for processing of the wastes by alternate methods. The liquid radwastes are classified, collected, and treated as high purity, low purity, chemical, or sludge. The terms high purity and low purity refer to the conductivity and not radioactivity.

Liquid Radwaste Subsystems

High-Purity Wastes

High-purity (low conductivity) liquid wastes are collected in the waste collector tank from the following sources:

- Drywell Equipment drain sump.
- Reactor building equipment drain sumps.
- Radwaste building equipment drain sump.
- Turbine building equipment drain sump.
- Reactor water cleanup (RWC) system.
- Residual heat removal (RHR) system.
- Decantate from cleanup phase separators.
- Spent-fuel pool cooling and demineralizer system.
- Decantate from condensate phase separators.
- Decantate from waste sludge phase separator.
- Off-gas equipment process sump.

- Waste gas treatment building equipment drain sump.

The high -purity wastes are processed by filtration and ion exchange through the waste filter and waste demineralizer. After processing, the liquid is received in the waste sample tank where it is sampled. Then, if it is satisfactory for reuse, it is transferred to the condensate storage tank (CST) as makeup water.

If the analysis of the sample reveals water not meeting specification for reuse, it is returned to the system for additional processing by the waste filter-demineralizer train. Occasionally, water quality below Technical Specifications limits for disposal after dilution may be discharged from the plant because of excess water inventories or unexpected occurrences.

Low-Purity Wastes

Low-purity (moderate-conductivity) liquid wastes are collected in the floor drain collector tank from the following sources:

- Off-gas pipe trench floor drain sump.
- RHR system drain.
- Drain from reactor building ventilation room.
- Drywell floor drain sump.
- Reactor building floor drain sumps.
- Radwaste building floor drain sumps.
- Turbine building floor drain sump.

These wastes generally have low concentrations of radioactive impurities. Processing consists of filtration, ion exchange, and subsequent transfer to floor drain sample tanks for sampling and analysis.

Treated low-purity wastes below Technical Specifications limits are discharged from the plant after dilution with cooling tower blowdown. However, if the treated wastes meet the specifications of water quality used in the plant and if the water inventory of the plant permits their recycle, they are returned to the CST for reuse.

Chemical Wastes

Chemical wastes collected in the chemical waste tank come from the following sources:

- Reactor waste cleanup flow glass drain.
- Fuel pool filter-demineralizer drain.
- Fuel pool chemical cleaning drain.
- Cask cleaning drains.
- Reactor and turbine building decontamination drains.
- Chemical addition system overflow and drains.

These chemical wastes are of such high conductivity as to preclude treatment by ion exchange. When the laboratory drains or other drains containing chemicals are received by and accumulated in the chemical waste tank, these wastes are processed by filtration (after being neutralized, if required). A chemical addition system made up of a storage tank and addition pump is provided to neutralize the contents of the waste storage tank prior to processing. If a decision is made to reuse the water, it is treated through an ion exchange unit and sent to the condensate storage tank. Alternatively, if the sampling and analysis indicate that the radioactivity concentrations are low enough to meet discharge criteria, the water in the sample tank is released to the discharge pipe. Wastes received in this subsystem generally represent excess inventory, and the processing method will generally produce treated waste of radioactivity content equal to or less than that of the high- and low-purity subsystems. Thus, release of this water is for inventory control and results in minimal activity discharge from the plant. Laundry and hot shower wastes are treated in the Unit 1 radwaste system as are laboratory drains.

Sludges

Expended filter-demineralizer ion exchange resins from the cleanup and condensate filter-demineralizer are removed when necessary by backwashing. Cleanup system sludges and sludges from the condensate polishing system are collected in the respective phase separators where excess backwash water is decanted to the waste collector tank and the sludge is accumulated. The fuel pool filer-demineralizer and waste filters are backwashed to the waste sludge phase separator. The accumulated resins and sludges are processed through the solid radwaste system after a suitable decay period.

Spent Resins

Expended ion-exchange resins from waste demineralizers are backwashed to spent resin tanks where the spent resins are stored for a suitable decay period. After sufficient decay, the resins are then sent to the solid radwaste system.

SAFETY EVALUATION

Normal Operation

Treated high-purity radwastes normally are routed to condensate storage for reuse. Treated floor drain wastes also can be routed to condensate storage to the extent practical, consistent with reactor water inventory and reactor water quality requirements. Treated floor drain and chemical wastes are discharged into the cooling tower blowdown discharge pipe after sampling of treated wastes to ensure discharge pipe concentrations are within Technical Specifications limits after dilution.

The effluent from the plant to the discharge pipe, all of which must pass through a sample tank, is monitored by taking batch samples; records of the volumes and concentration levels are retained. A process monitoring system is provided to indicate high-radiation levels in the release to the discharge pipe. On the annunciation of the high-radiation level alarm, the release of the liquid radwastes will be terminated.

The processing equipment is located within a concrete building to provide secondary enclosures for the wastes in the event of leaks or overflows. Tanks and equipment that may contain significant quantities of radioactivity are shielded. Except where flanges are required for maintenance, all pipe connections are welded to reduce the probability of leaks. Process lines that penetrate shield walls are routed to prevent a direct radiation path from the tanks or equipment for which shielding is required. The waste system is controlled from a local panel in the radwaste control room.

The radioactivity concentrations in the discharge system are well within the Technical Specifications limits. The components of the liquid radwaste are sized to collect and process the volume of liquid radwaste generated from the reactor under normal power operation and expected occurrences.

Conclusions

Because leaks or spills from the liquid radwaste system go into the radwaste building and/or the reactor building, they do not cause doses at the plant boundary exceeding the limits of 10 CFR 20; because the system is monitored for inadvertent discharge of high-level waste, the liquid radwaste system fulfills the design basis and adheres to the guidelines of 10 CFR 20.

B. GASEOUS EFFLUENT TREATMENT SYSTEMS

The gaseous effluent treatment systems are designed to process and control the release of gaseous radioactive wastes to the site environs so that the total radiation exposure to individuals outside the controlled area is as low as reasonably achievable (ALARA) and does not exceed applicable regulations.

DESIGN BASES AND OBJECTIVES

1. The gaseous effluent treatment systems are designed to limit offsite concentrations from routine station releases to significantly less than the limits specified in 10 CFR 20.1-20.601 (found in 10 CFR published before January 1994) and to stay within the limits established in the plant operating license.

2. A noble gas input equivalent to an annual average off-gas rate (based on 30-min decay) of 100,000 μCi/s of the "1971 mixture" has been used as a design basis. A conservative value of 40 sf^3/min for condenser air in leakage has been used as a design basis.

3. Process and control the release of gaseous radioactive effluents to the site environs so as to maintain ALARA the exposure of persons in unrestricted areas to comply with Appendix I to 10 CFR 50.

4. The radiation dose design basis for the treated off-gas is to delay the gas until the required fraction of the radionuclides has decayed. The daughter products are retained by the charcoal and the high-efficiency particular air (HEPA) filters. FSAR Subsection 3.8.7 provides seismic evaluations of the radwaste facilities buildings.

SYSTEM DESCRIPTIONS

Off-Gas Recombiner Charcoal (RECHAR) System

Noncondensible radioactive off-gas is continuously removed from the main condenser by the air ejector during plant operation. This is the major source and is larger than all other sources combined. The air ejector off-gas normally contains activation gases, principally N-16, O-19, and N-13. The N-16 and O-19 have short half-lives and are readily decayed. The 10-min N-13 is present in small amounts that are further reduced by decay.

The air ejector off-gas also contains the radioactive noble gas parents of biologically significant Sr-89, Sr-90, Ba-140, and Cs-137. The concentration of these noble gases depends on the amount of tramp uranium in the coolant and on the cladding surfaces (usually extremely small) and the number and size of fuel-cladding leaks. An off-gas RECHAR system is provided to treat this source; the system utilizes catalytic recombinations and charcoal adsorption as discussed below. The major system components are located in the turbine building at el 112 ft and in the waste gas treatment building.

Other Gaseous Effluent Treatment Systems

Some radioactive gas may be released from other deliberate ventilation paths such as from the reactor building, turbine building, or radwaste building. Iodine and particulate monitors are installed at the points of deliberate release of ventilation air which could have potentially significant amounts of radioactive material. Treatment involving holdup or filtration has been provided for each potential path for gaseous release as discussed for each source below.

Radwaste Building

The radwaste building ventilation system was designed to minimize the potential for releasing airborne radioactivity from the radwaste building to the environs. The ventilation system includes redundant supply fans, supply air filters, exhaust air filter trains, and redundant exhaust fans.

The supply air is ducted to the different areas of the radwaste building. The exhaust air is ducted to the filter trains and released via the reactor building vent plenum. The filter train consists of a bank of carbon adsorbers and a bank of HEPA filters to minimize particulate and halogen releases. Radiation monitors survey the bank performance with high level annunciation in the main control room. These monitors are backed up by the reactor building vent plenum isokinetic probe.

The charcoal filters contain charcoal impregnated with TEDA with a minimum expected efficiency of 99 percent. This type of impregnant is used to obtain increased charcoal adsorption efficiency at low concentrations and because of its favorable weathering characteristics for a continuously operated system.

C. SOLID RADWASTE SYSTEM

The solid radwaste system collects, monitors, processes, packages, and provides temporary storage facilities for radioactive solid wastes for offsite shipment and permanent disposal. The Edwin I. Hatch Nuclear Plant Solid Radioactive Waste Process Control Program (PCP) describes this objective. The PCP is implemented by procedures which contain formulas, sampling, analyses, tests, and determinations to be made to ensure the processing and packaging of solid radioactive wastes, based on demonstrated processing of actual or simulated wet solid wastes, are accomplished to assure compliance with Title 10 Code of Federal Regulations (CFR) Parts 20, 61, and 71, as well as State regulations and burial ground requirements governing the disposal of solid radioactive waste.

DESIGN OBJECTIVES

The design objectives of the solid radwaste system are:

- To provide collection, processing, packaging, and storage of solid wastes resulting from normal plant operations without limiting the operation or availability of the plant.

- To provide a reliable means for handling solid wastes and to allow system operation with as low as reasonably achievable (ALARA) radiation exposure of plant personnel.

- To package radioactive solid wastes for offsite shipment and burial in accordance with applicable regulations including 49 CFR 170-178.

- To prevent the release of significant quantities of radioactive materials to the environment so as to keep the overall exposure to the public well within 10 CFR 20.1-20.601 (found in 10 CFR published before January 1994) limits.

- To compact and bale low radiation level solid, compressible wastes such as air filters, paper, contaminated clothing, rags, cloth smears, and shoe covers.

SYSTEM INPUTS

The activities of the solid wastes entering this system are dependent on the liquid activities in the various liquid systems such as the condensate, reactor water cleanup, fuel pool cleanup, equipment drain, and floor drain systems, whose activities are in turn a function of the reactor coolant activity.

The quantities of solid wastes generated is dependent upon the plant operating factor, extent of equipment leakage, plant maintenance and housecleaning, and decontamination requirements.

Input to the solid radwaste system is made up predominantly of powdered resins from various plant filters, with some bead resins from plant demineralizers.

Wet Solid Waste Inputs

The wet solid radwaste system is a continuous part of the liquid radwaste system. Wet wastes, consisting primarily of spent demineralizer resins and powdered filter resins, are accumulated in phase separators and waste sludge tanks. These tanks serve as storage and batching tanks for the wet solid radwaste system.

Dry Solid Waste Inputs

Dry wastes consist of air filters, miscellaneous paper, rags, etc., from contaminated areas; contaminated clothing, tools, equipment parts that cannot be effectively decontaminated, and solid laboratory wastes. The activity of much of this waste is low enough to permit handling by contact. These wastes are collected in containers located in appropriate zones around the plant, as dictated by the volume of wastes generated during operation and maintenance. The filled containers are sealed and moved to a controlled-access enclosed area for temporary storage. Compressible wastes are compacted into 55-gal steel drums in a hydraulic press-baling machine to reduce their volume. Ventilation is provided to control contaminated particulate while this packaging equipment is being operated. Noncompressible wastes are packaged manually in similar 55-gal steel drums. Because of its low activity, this waste is stored until enough is accumulated to permit economical transportation to an offsite burial ground for final disposal.

Irradiated Reactor Component Inputs

Because of the high activation and contamination levels, used reactor equipment is stored in the spent-fuel storage pool for sufficient radioactive decay before removal to inplant or offsite storage and final disposal in shielded containers or casks.

Waste Oil Inputs

Waste oil is handled independently from other waste collection and waste disposal systems. Waste oil is collected from various plant applications and mixed with a solidification media in 55-gal drums. Once the contents of these drums are solidified, the drums are secured and temporarily stored in the waste separation and temporary storage facility prior to being shipped for final burial.

EQUIPMENT DESCRIPTION

The solid radwaste system, including solidification equipment, is nonseismic. The exterior filling station is equipped with locked-shut discharge valves (when not in use) to prevent an inadvertent discharge. The solid radwaste system was built, to the extent practicable, to American Society of Mechanical Engineers (ASME) Code, Section III, Class 3 standards. Certain items, such as the solidification mixers, are standard commercial units built to ASME Code, Section VIII standards. In general, where equipment could not be supplied, ASME Code, Section III, Class 3 parallel documentation was provided to ensure quality control commensurate with the importance of the system. Replacement components to the solid radwaste system may be procured in accordance with Table 1 of Regulatory guide 1.26, September 1974 (reference 1), and Table 1 of Regulatory Guide 1.143, October 1979 (reference 2).

Radiation exposure to operating personnel is limited to a level ALARA by providing remote, shielded operating stations for the drumming and solidification processes. Where possible, drivers for the drumming and solidification equipment are placed outside of the radiation area behind shield walls. The equipment is also provided with flush water service to prevent the accumulation of radioactive material.

Administrative procedures are employed to minimize operator exposure. These include daily planning of radwaste processing, control of the reactor water inventory, and carrying out a preventive maintenance program. In addition, good housekeeping procedures are followed to minimize the quantities of dry radwaste generated during plant operation.

Solidification Equipment

The solidification system provides the means for pumping the resin and filter sludge slurries from their storage tanks to a filling station at the exterior of the radwaste building where they are solidified with Portland cement or dewatered in large shielded containers.

The large-container fill station is designed to accommodate any size truck-mounted shipping container.

The exterior fill system is nonsafety related. Table 1 of Regulatory Guide 1.143 specifies applicable codes for equipment purchased for radwaste service. The system consists of pump and control skids, disposable liners, and flexible interconnecting piping. It is constructed of standard industrial components.

Hydraulic Press

The hydraulic press is provided so soft compressible wastes such as paper, rags, and clothing can be reduced in volume. The press is designed to compress these wastes in a 55-gal steel drum by a vertical moving piston at about 85 psig.

An integral part of the hydraulic press is the ventilation system which controls airborne particular matter during the compressing operation. The ventilation system for the hydraulic press enclosure consists of an induced-draft fan of approximately 600-ft^3/min capacity and a filtering unit containing a prefilter and high-efficiency particulate air filter. Air openings are located around the bottom of the enclosure to increase the draft effect. The air induced through the hydraulic press enclosure is discharged, after filtration, into the area housing the unit.

Waste Oil Solidification Equipment

Waste oil is mixed with a solidification media in 55-gal drums and disposed of. The equipment used to mix the oil and solidification media is a portable, self-containing mixing unit with an explosion-proof electric motor.

VOLUMES

There is approximately 20,000 ft^3 of wet, solid, and concentrated liquid radwaste generated per year.

The 20,000 ft^3 represents unsolidified waste. Between 3500 and 4500 55-gal drums are required per year to ship the waste to the burial site.

PACKAGING

Solid radwastes are packaged and shipped in 55-gal drums, large shielded containers, or high-integrity containers which meet Nuclear Regulatory Commission and DOT requirements.

Wet solid wastes are packaged by one of the appropriate methods below:

- In high-integrity containers without further processing if the packaged content has less than 1-percent free water.
- In 55-gal drums or large shielded containers if the packaged content has less than 0.5-percent free water and less than 1 μCi/cc with a half-life equal to or greater than 5 years.
- Solidified in large shielded containers.

Filling of large shielded containers and high-integrity containers at the exterior fill station is done from a remotely operated control panel to minimize operator exposure.

Dry compressible solid radwaste is compacted in 55-gal drums by a hydraulic press.

D. STORAGE FACILITIES

The waste separation and temporary storage facility consists of a precast concrete building. The facility is designed to allow temporary (up to 5 years) storage of compacted dry radioactive trash, solidified liquids or resins, low specific activity boxes of radioactive trash, and radioactive tools. The principal item stored is dry radioactive trash compacted into 55-gal steel drums. Maximum storage capacity is 65,000 ft^3 or 8720 drums.

SHIPMENT

Solid wastes are regularly shipped from the site to the burial ground by trucks operated by a licensed shipper. The waste packages are shipped unshielded or in shielded shipping casks as required to fully comply with 49 CFR 170-1909, namely:

1. The dose rate is less than 2 mrem/h in the cab, 10 mrem/h at 6 ft from the vehicle surface, and 200 mrem/h at any point on the surface of the vehicle. When the vehicle does not conform, the drums are rearranged and/or shielding is placed appropriately inside the vehicle to meet these levels.

2. The vehicle smears are less than 2200 dpm[11]/100cm^2 beta-gamma and/or 200 dpm/100 cm^2 alpha.

3. Drums are labeled with the applicable radioactive materials label indicating the isotopes contained, curie content, and date of assay.

4. Shipping of large filled liners requires lifting of the liner with a crane. Failure of the rigging or failure of one or more of the lifting eyes on the liner results in a liner drop accident. Crane lifts are not made during periods of high winds or inclement weather, to minimize the potential for handling accidents.

A hypothetical liner drop accident represents nothing more than a radioactive spill outside the confines of the radwaste building. A liner drop has not impact on the integrity of the building structure.

The consequence of a filled liner handling accident have been evaluated. As the contents of the liner are dry (either dewatered or solidified), they remain in place if a liner bursts when dropped. Since lifts are not made on rainy days, spills can be cleaned up without offsite release of radioactivity.

All containers used for offsite shipment and burial of radwastes are DOT approved, meeting the requirements established in 49 CFR.

When used for shipping radwaste from the site, the trucks are used on an exclusive basis and are placarded per the previously mentioned code.

The drummed radwaste is not normally stored in any area other than the storage area. Should the occasion arise, a full or partially loaded truck can be stored on the site in a restricted area. The truck would be barricaded and "Radiation Area" or "High Radiation Area" signs conspicuously posted as required.

2.6.2.5 North Anna 1

[11] dpm = disintegrations per minute.

A. LIQUID WASTE DISPOSAL SYSTEM - DESIGN OBJECTIVES

The liquid waste disposal system was designed to satisfy the applicable sections of the general design criteria. In addition, this system was designed to meet the criteria of 10 CFR 20, 10 CFR 50, and 10 CFR 100 so as not to endanger the health of station operating personnel or the general public. Transportation of radioactive materials from the station will be carried out in a manner that will conform with all applicable Federal, state, and local ordinances. Liquid radioactive waste system components have been designed according to Section VIII of the ASME Boiler and Pressure Vessel Code.

The liquid waste disposal system is common to both reactor units and accommodates the radioactive wastes produced during simultaneous operation of the two units.

SYSTEM DESCRIPTION

The liquid waste disposal system was designed to receive, process, and discharge potentially radioactive liquids from a variety of sources, including the chemical and volume control system, the boron recovery system, the steam generator blowdown system, the vent and drain system sumps, laboratory drains, personnel decontamination area (PDA) drains, the decontamination system, the sampling system, laundry drains, and spent resin flush water. The system design considers potential personnel exposure and ensures that radioactive releases to the environment are as low as reasonably achievable (ALARA). During normal plant operation, the total activity from radionuclides leaving the discharge canal does not exceed the limits of applicable regulations.

All pipes containing significant radioactivity are routed within appropriately shielded areas, as specified on design drawings. Pipes are field run only to the extent that the pipe lengths necessary to allow the pipes to fit in the appropriate shielded areas are determined in the field.

With the exception of the drumming station, ion exchanger filtration system (IEFS), waste disposal building, demineralizer, and spent resin transfer equipment , liquid waste processing equipment is located below grade in the auxiliary building or decontamination building. These portions of the auxiliary building and decontamination building are designed according to Seismic Class I criteria.

Offsite dose calculations consider only liquid waste treatment by ion exchange and filtration. NUREG-0017 was used to estimate equipment performance.

OPERATING PROCEDURES

System influents from the vent and drain system, which include the effluent from various building sumps, are directed by valve lineup to either the high-level or low-level waste drain tanks, according to influent activity level.

Laundry waste and cold laboratory drainage, personnel decontamination area (PDA) shower drainage, and PDA sink drainage are discharge into the contaminated drain tanks.

Non-laboratory drainage and spent resin flush water are discharged directly into the high-level waste drain tanks.

High-level liquid waste from the vent and drain, liquid waste disposal, chemical and volume control, and boron recovery systems is discharged to the high-level waste drain tanks. The contents of the high-level waste drain tanks, which may have activity levels of up to 10^{-1} μCi/ml, are processed by the ion exchanger filtration system. The contents of these tanks may be transferred to the low-level waste drain tanks by means of a line under administrative control in the event that the high-level waste drain tank contents do not require further treatment. The decontamination system fluid waste treating tank in the decontamination building can be used for additional storage of high-level wastes. The influent to the high-level drain tanks also may include the contents of the low-level drain tanks and the contaminated drain tanks should the activity level of the liquids in these tanks exceed about 10^{-3} μCi/ml. The high-level tanks afford a holdup period for sampling the liquid before it is processed.

The low-level waste drain tanks accumulate low-level waste liquid from the vent and drain and boron recovery systems as well as the fluid waste treating tank, and boron recovery test tanks. The contents of the low level waste drain tanks are pumped to the waste header and are discharged directly to the Circulating Water System or are processed through the Liquid Waste Demineralizer, if needed prior to discharge.

The demineralizers in the Waste Disposal Building also could receive liquids from the contaminated drain tank, the steam generator blowdown tank, and the blowdown from the service water reservoir. These liquids are monitored prior to release to ensure that the limits of 10 CFR 20 will not be exceeded. Offsite dose calculations, based on effluent samples obtained at this release point, are performed to ensure the limits of 10 CFR 50, Appendix I are not exceeded.

All liquid waste discharges to the circulating water system are monitored to ensure radiological control. Periodic sampling of the liquid waste effluent is conducted. Liquid waste discharges are automatically isolated downstream of the clarifier demineralizer filter on a signal from the radiation monitor. This valve is also operated remotely from the main control room or automatically by a signal from the clarifier surge tank level switches. High activity detected by the radiation monitor overrides the valve control and stops all discharge flow. The discharge flow from the liquid waste disposal system is combined and mixed with the water in the circulating-water discharge tunnel so that the concentration of activity of the combined effluent is maintained ALARA and well within the limits established by applicable regulations.

B. GASEOUS WASTE DISPOSAL SYSTEM

DESIGN OBJECTIVES

The gaseous waste disposal system is designed to maintain effluent radioactivity levels as low as practicable and below the limits of applicable regulations. The system is designed to satisfy the applicable sections of the general criteria of Section 3.1, to conform with original AEC and present NRC general design criteria, and to meet the intent of 10 CFR 20, 10 CFR 50, and 10 CFR 100, so as not to endanger the health of station operating personnel or the general public.

The gaseous waste disposal system is common to both units and is sized to treat the radioactive gases released during simultaneous operation of both units. Fission product gases and uncondensed radioactive vapors are held for decay, filtered, and diluted with ventilation air until they may be safely released through one of the two vent stacks on top of the Unit 1 containment.

The gaseous waste disposal system is designed to provide adequate storage for radioactive decay time of the waste gases and, in addition, provide for holdup of these gases when adverse meteorological conditions make it desirable to discontinue release of waste gas to the environment.

SYSTEM DESCRIPTION

The system is designed to receive, decay, process, dilute, and discharge potentially radioactive gases, fission product gases, and uncondensed vapors from the vent and drain system, boron recovery system, primary coolant leakages, and the reactor plant. The design minimizes possible personnel exposure and ensures that radioactive releases to the environment are ALARA.

C. SOLID WASTE SYSTEM

As originally designed, the waste solidification system used urea formaldehyde as a solidification agent, as did numerous other nuclear plants such as Trojan and Palisades. However, experience throughout the industry has demonstrated that this system needs further development to assure reliable solidification, elimination of free water, and no unacceptable leaching. Consequently, the system is not used. Waste is now being processed for shipment by dewatering and shipment in high-integrity containers. Final shipment preparations (inspection, health physics approval, etc.) remain the responsibility of Vepco.

The following discussion describes the basic procedures for disposing of various types of waste, all within regulations of the NRC, the Department of Transportation, and the receiving burial site.

DESIGN OBJECTIVES

The solid waste disposal system provides holdup, packaging, and storage facilities for the eventual shipment off the site and the ultimate disposal of radioactive waste. Materials that may be handled as solid waste include spent resin slurries; spent filter cartridges; and other miscellaneous solid radioactive material resulting from station operation and maintenance.

SYSTEM INPUTS

Spent Resins

It is estimated that 1500 ft^3/yr/unit of resin will require disposal. This material will be transferred as slurry to be dewatered and shipped, in disposal containers, which are placed in shipping shields as required. The disposal containers will be placed in shipping containers if necessary for offsite shipping and disposal. The shipping shields are generally reused.

Miscellaneous Solid Waste

Rags, gloves, boots, brooms, filter cartridges, and other miscellaneous tools and apparel that become contaminated during normal operation and cleanup will be handled as described below; the amount may be approximately 1500 ft^3/yr/unit. Spent filters may be changed at expected rates of 175 ft^3/yr/unit. spent filters may be changed at expected rates of 175 ft^3/yr/unit. Those filters that are highly radioactive will be processed as described below.

EQUIPMENT AND OPERATION

When solidification operations are necessary, acceptable vendors supply this service which generally follows that described below and must adhere to the requirements of the Process Control Program.

Solidification Operation

It is not expected that solidification will be used.

The solidification operation involves the mixing of the waste material in a disposal container with a solidification agent plus other appropriate reagents. The resultant mixture solidifies into a free-standing, solid mass with no free water. The disposal containers may be placed within shipping shields before the solidification process to meet radioactive material transportation regulations.

The solidification process takes place in a "fill" area within the waste solidification and shipping area of the decontamination building. The complete waste solidification and shipping area is serviced by an overhead crane.

The solidification process is capable of operating with either liquid waste, evaporator bottoms, or spent resins. Before solidification of spent resins, the resins are partially dewatered.

The radioactivity level on contact with the surface of the disposal liner or shipping shield is measured, recorded, and attached to the outside surface in accordance with applicable Federal regulations. The containers with or without shipping shields are stored until such time as they are shipped off the site for ultimate disposal.

Baling Operation

Contaminated solid materials resulting from station maintenance are stored in specified areas of the auxiliary building and the decontamination building. These items are placed in suitably labeled polyethylene bags for storage.

Materials that are compressible, such as absorbent paper, cloth, rubber, and plastic, are placed in 55-gallon drums. The drum and its contents, including plastic bags, are placed in position on the solid waste bailer. The compression plate of the bailer compacts the contents of the drum into high-density material. Additional compressible materials are added and the contents of the drum are recompacted until the drum is filled. During compression, a hood covers and seals the drum top to permit air and dust to be exhausted from the drum through an absolute filter. Contaminated metallic material and highly contaminated solid objects are placed inside disposable containers for shipment to a burial facility. Compressible materials and other contaminated solid materials that are not drummed are placed in 20 foot seavans for shipment to a vendor for processing prior to shipment to a burial facility. The type of material that is collected in the seavan determines the type of processing that it will undergo. If the material is designated as incinerable it will be burned. The resulting ash residue will be shipped by the vendor to the disposal site for burial. If the material cannot be incinerated it will be compacted. The compacted material will be shipped by the vendor to the disposal site for burial.

Spent Resin Handling Operation

Spent resin facilities are located below grade in the decontamination building. This portion of the decontamination building is designed to Seismic Class I criteria.

A shielded resin holdup tank accumulates spent resin from ion exchangers. A transfer system permits the spent resin to be flushed from the hold tank to be dewatered and shipped.

The resin in an ion exchanger is considered to be spent when the decontamination factor drops below a predetermined value, the dose rate on the outside of the ion exchanger approaches a predetermined value, or the pressure drop across the ion exchanger becomes excessive. The unit is then isolated and primary-grade water or recycled resin flush water is used to flush the spent resin into the spent resin holdup tank. The spent resin remains in the holdup tank and flushed liquid passes through a filter and discharges by way of the spent resin dewatering tank and the vent drain system to one of the waste drain tanks.

There is no significant temperature increase in the spent resin holdup tank due to decay heat. An extremely conservative analysis shows that the maximum conceivable temperature rise in the resin is 45°F.

Spent Filter Cartridge Handling Operation

Filters in radioactive liquid service are removed from service when the pressure drop across the filter becomes excessive or the radiation level approaches the transport cask shielding capabilities. To remove the expended cartridges from filters that are located in limited access, shielded cubicles, the filter removal shield is positioned on the shield floor over the filter vessel after removal of the shield plug. The filter cover is opened remotely and the cartridges are drawn up into the shield. The spent filter and shield are transferred to the waste solids area. The spent filter is lowered into a shielded disposable container (High Integrity Container - HIC) in preparation for disposal.

Other filters that are not located in limited access, shielded cubicles, are removed without the use of the filter removal shield. These filters are removed and transported to Waste Solids under the provisions of specific procedures and ALARA considerations.

PACKAGING

Material handled as radioactive solid waste may include spent resin, spent filter cartridges, sludges, and miscellaneous solid materials resulting from station operation and maintenance, such as contaminated rags, paper, and equipment parts.

For ultimate disposal, these wastes are packaged and shipped off the site to specifically approved burial grounds. The packaging meets all applicable NRC and U.S. Department of Transportation (DOT) regulations (10 CFR 71 and 49 CFR 170 through 179) for transportation of radioactive materials.

Originally, all waste was to be packaged in either 55 gal drums (7.5 ft^3) or in cylindrical containers of 50 ft^3 capacity. However, containers of approximately 101, 121, and 200 ft^3 are also being used. The choice of container size depends on the type, size and shape, radioactivity, etc., of the waste. The total quantity of waste to be shipped in the containers is a function of the ratio of materials, the waste activity, and the shipping shield to be used to meet transportation regulations.

Shipping shields are designed to provide the maximum amount of shielding during the filling operation. In addition, a filling shield is provided to limit operator dose. This filling shield is a cylindrical lead and steel device around the inlet lines to the disposable container, which also acts as a splash shield. The inlet lines can be remotely removed to lessen operator dose. The filling and solidification process is continuously monitored by a radiation monitor. The solidification process may take place within shielded containers behind shield walls. Thus, the operator dose rate is as low as reasonably achievable.

The absence of free water can be determined by visual inspection or by a mechanical probe put into the top of disposable containers through a normally sealed, screwed cap.

The fill area is lined with stainless steel for each of decontamination. All floor drains from the storage and shipping areas are piped to the decontamination system, which discharges to the High Level Liquid Waste tanks.

Vepco contracts for waste disposal transportation and burial services. Since there are variations in overpacks between contractors, specific details of their construction are not incorporated herein. These details of construction, packing, and permissible levels of activity, and a copy of required special permit for overpacks, are maintained on file by Vepco. Vepco uses only approved containers for shipment, in accordance with the requirements of applicable regulations.

SHIPMENT

The normal mode of shipment of radioactive wastes from the North Anna Power Stations is by truck; however, shipment by rail is also possible. All shipments will conform to applicable DOT and NRC regulations.

The ultimate solid waste disposal site is dependent on specific contract requirements formulated for waste disposal.

2.6.2.6 Summer

A. LIQUID WASTE SYSTEMS

This section describes the design and operating features of the liquid waste processing system (LWPS).

<u>Design Objectives</u>

The LWPS is designed to receive, control, segregate, process, recycle and discharge liquid wastes. The system design considers potential personnel exposure and assures that quantities of radioactive releases to the environment are in accordance with 10 CFR 50, Appendix I.

Under normal plant operation, the activity from radionuclides leaving the penstock of the Fairfield Pumped Storage Facility, due to releases from the LWPS, is a small fraction of the concentration limits as defined in Appendix B of 10 CFR 20.

During operation with excessive reactor coolant leakage or temporary malfunction in the LWPS additional and/or alternate processing capacity is available and utilized in order to limit releases to approximately the same as during normal operation.

<u>Systems Descriptions</u>

The LWPS collects and processes potentially radioactive wastes for recycle or for release to the environment. Provisions are made to sample and analyze fluids before they are discharged. Based on the laboratory analysis, these wastes are either released under controlled conditions via the penstocks of the Fairfield Pumped Storage Facility or retained for further processing. A permanent record of liquid releases are provided by analyses of known volumes of waste.

The bulk of the radioactive liquids discharged from the reactor coolant system are processed and recycled by the boron recycle system. This limits input to the LWPS and results in processing of relatively small quantities of generally low activity level wastes.

The LWPS is arranged to recycle reactor grade water entering the system. This is implemented by the segregation of equipment drains and waste streams which prevents the intermixing of liquid wastes. The LWPS consists mainly of two subsystems designated as Drain Channel A and Drain Channel B. Drain Channel A normally processes all water which can be recycled and Drain Channel B normally processes all water which is to be discharged. Capability for handling and storage of spent demineralizer resins is also provided.

The LWPS does not include provisions for processing secondary system wastes. The segregation of primary and secondary side wastes is maintained since ammonia from the secondary side could result in the loss of LWPS demineralizer efficiency, and condenser inleakage could lead to undesirable chemical inclusion in the LWPS. Additionally, the mixing of low activity wastes (secondary side) with those of higher activity (primary side) should be avoided since a large volume of contaminated water is produced. The present design, which segregates primary and secondary wastes, minimizes the amount of water which must be processed by discharging low activity wastes directly, where permissible, with no treatment.

In the event of equipment faults of moderate frequency (Section 11.2.4.2), the LWPS is capable of processing up to 1 gpm of primary coolant leakage with no change in system operation. The load on the waste evaporator is increased over that during normal operation.

As a practical upper limit of system operation, the LWPS can process 6 gpm not including laundry type effluents which are normally discharged without evaporative processing. This liquid may be collected in either the floor drain tank (Drain Channel B) or waste holdup tank (Drain Channel A) or in both tanks.

It is possible to operate the LWPS at a 6 gpm processing rate for an indefinite period of time. However, close operator surveillance is required. Also, the radioactive discharge must be kept within the 10 CFR 50, Appendix I limits. Assuming the discharge limits are not exceeded and with no equipment malfunctions, the LWPS may process over 3,000,000 gallons per year through the waste evaporator. Process capacity of up to 30 gpm is available for short periods of time (days).

Determination of this “upper limit” capacity does not consider the backup capability of the boron recycle system evaporator which may also be used in the event of excessive leakage to the LWPS. Other sections of the LWPS such as the laundry subsystem and the reactor coolant drain tank subsystem, are capable of processing liquid with no additional load on the waste evaporator. These portions of the system further add to the LWPS capacity.

Instrumentation and controls necessary for the operation of the LWPS are located on a control board in the auxiliary building. Any alarm on this control board is relayed to the main control board in the control room.

Recycle Portion (Drain Channel A -- Tritiated and Aerated Water Sources)

Drain Channel A is provided to process reactor grade water which enters the LWPS via equipment leaks and drains, valve leakoffs, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources. Deaerated tritiated water inside the reactor building from sources such as valve leakoffs, which is collected in the reactor coolant drain tank, need not enter Drain Channel A. These may be routed directly to the boron recycle holdup tanks for processing.

Administratively controlled equipment drains are the major contributors of water which can be recycled. Valve and pump leakoffs outside the reactor building are also collected in the waste holdup tank for processing and recycle. Abnormal liquid sources include leaks which may develop in the reactor coolant and auxiliary systems. Considerable surge and processing capacity is incorporated in the recycle portion of the LWPS to accommodate abnormal operations.

The basic composition of the liquid collected in the waste holdup tank is boric acid and water with some radioactivity. Liquid collected in this tank is normally evaporated to remove radioisotopes, born and air from the water so that it may be reused in the reactor coolant system. Evaporator bottoms are normally drummed unless found acceptable for boric acid recycle. The condensate leaving the LWPS waste evaporator may pass through the waste evaporator condensate demineralizer and then enter the waste evaporator condensate tank. When a sufficient quantity of water has collected in the waste evaporator condensate tank, it is normally transferred to the reactor makeup water storage tank for reuse. Samples are taken at sufficiently frequent intervals to assure proper operation of the system to minimize the need for reprocessing. If a sample indicates that further processing is required, the condensate may be passed through the waste holdup tank for additional evaporation. The waste evaporator condensate tank is supplied with a diaphragm to exclude air.

Waste Portion (Drain Channel B -- Non-Reactor Grade Water Sources)

Drain Channel B is provided to collect and process non-reactor grade (non-recyclable) liquid wastes. These include floor drains, equipment drains containing non-reactor grade water, laundry and hot shower drains, and other non-reactor grade sources. Drain Channel B equipment includes a floor drain tank and filter, laundry and hot shower tank and filter, chemical drain tank, waste monitor tank demineralizer and filter, two waste monitor tanks, and waste evaporator.

Non-recyclable reactor coolant leakage enters the floor drain tank from system leaks inside the reactor building via the reactor building sump and from system leaks in the auxiliary building via the floor drains. This liquid is not recycled because it is diluted and contaminated by non-reactor grade water entering the floor drain tank from other sources. Non-reactor grade water enters the floor drain tank from the sample room, chemical laboratory, reactor building sump and auxiliary building floor drains. Sources of water to the reactor building sump and auxiliary floor drains are fan cooler leaks, secondary side steam and feedwater leaks, component cooling water leaks and decontamination water.

Waste From Spent Resin

The spent resin sluice portion of the LWPS consists of a spent resin storage tank, a spent resin sluice pump, and a spent resin sluice filter. The equipment is arranged such that the resin sluice water after entering a demineralizer vessel returns to the spent resin storage tank for reuse. The purpose of this system is to transport spent resin to the spent resin storage tank without generating large volumes of waste liquid. This is accomplished by reusing the sluice water for subsequent resin sluicing operations.

Tank Overflow Protection

All tanks in the chemical and volume control system (CVCS), boron recycle system (BRS), nuclear blowdown processing system (NBS) and WPS that could potentially contain radioactive liquids are designed to provide adequate warning of potential overflow conditions. These tanks are provided with level indication instrumentation which has an alarm function on high liquid level in the tank. Alarm annunciation is provided separately on the local system control panel and further relayed to a common annunciator on the main control board in the control room for each system.

In addition to tank level monitoring and warning of potential overflow conditions, provisions are made in the systems design to collect and process overflows from tanks containing potentially radioactive liquids.

B. GASEOUS WASTE SYSTEM

Design Objectives

The gaseous waste processing system (GWPS) is designed to remove fission product gases from the reactor coolant in the volume control tank. The system is also designed to collect gases from the boron recycle and waste evaporators, reactor coolant drain tank, recycle holdup tanks and reactor vessel. The system has the capacity for long term storage.

Under normal operation, the annual releases due to leakage and routine releases from the GWPS will be sufficiently low such that site boundary doses will be a small fraction of regulation requirements.

The system is capable of operating under conditions of fuel defects in combination with equipment faults of moderate frequency.

The system is designed to preclude the possibility of an internal explosion. However, the system volume is distributed so that the dose in the unlikely event of an explosion is approximately the same as the dose due to a gas decay tank rupture.

System Description

The GWPS consists mainly of a closed loop comprised of two wastes gas compressors, two catalytic hydrogen recombiners, and gas decay tanks to accumulate the fission product gases. The routing of piping containing radioactive gases is either through shielded cubicles or behind shield slabs.

Components of a similar design to those used in the GWPS have been operating for several years with excellent performance. Systems constructed from carbon steel have been in service for more than three years and no failure due to corrosion damage has been reported.

The major input to the GWPS during normal operation is taken from the gas space in the volume control tank.

C. SOLID WASTE SYSTEM

Design Objectives

The solid waste system is designed to package and/or solidify radioactive wastes for shipment to an approved offsite burial facility in accordance with applicable Department of Transportation (DOT), NRC and State regulations. The system conforms to 10 CFR 20 and 10 CFR 50 requirements by providing shielding so that radiation exposure of operating personnel and the public is within acceptable limits. Solid waste packaging is accomplished in an area located on the ground floor (elevation 436') of the auxiliary building, a Seismic Category I structure.

Design, fabrication and testing of solid waste system components and piping is in accordance with ANSI B31.1 and other accepted standards referenced by ANSI B31.1. Additional on-site system tests will be performed using nonradioactive materials prior to commercial operation. Packaging and shipping conform to 49 CFR 171 through 49 CFR 178.

Individual container shields and casks are used, when required, to maintain radiation levels within applicable radioactive materials regulation.

System Inputs

Radioactive waste packaged includes:

1. Evaporator bottoms.
2. Chemical laboratory samples.
3. Spent resins.
4. Used filter cartridges.
5. Radioactive hardware.
6. Compacted waste such as rags, paper, clothing, etc.

Secondary side condensate polisher resin may also be handled by the solid waste system (refer to 10.4.6).

Equipment Description

Processing

The input to the solid waste system consists of the contents of four radioactive waste storage tanks containing waste evaporator concentrates, chemical laboratory samples, primary spent resins and nuclear blowdown spent resins and the associated valves, piping and pumps. These components are located at elevation 412' in the auxiliary building except for the chemical drain tank which contains spent chemical laboratory samples and is located at elevation 374' of the auxiliary building.

Radwaste solidification when required is accomplished using approved vendor-supplied equipment and process control program. Liquid waste contained in the Chemical Drain Tank and Waste Evaporator Concentrates Tank is recirculated using their respective pumps and a sample is taken. This sample is used in the Process Control Program to determine pH adjustment, waste/binder ratio, and for the purpose of test solidification. Liquid waste is transferred to the fill head and into the liner located in the solidification area.

Primary and Secondary spent resins are transferred from their respective holdup tanks to either a disposable liner in the solidification area or a liner which is already in a cask ready for transport in the truck bay. The resins may then be either solidified or dewatered for shipment. Dewater return is routed to the Excess Liquid Waste Hold up Tank, the Decon Pit Collection Tank, or the Floor Drain Tank.

Each waste transfer is immediately followed by a flush operation of the waste transfer piping and the internals of the fill head when used.

Labyrinth shield walls separate the drumming station control room, the piping process skid cubicle, and the container fill area from one another.

Waste Containers and Shielding

All wastes are packaged in containers which meet DOT requirements. The containers used for solidification and resin dewatering provide appropriate connections for processing.

The processing of most of the liquid waste volume will be in the solidification area. This area is enclosed on three sides by walls for shielding and includes a curb to contain spills. A movable shield may be brought in if additional shielding is required. Higher activity wastes will be processed with the liner already in the transport cask located in the truck access area. A double lid cask top will be used to limit exposure in this area. The main part of the lid shields the entire top of the cask except the immediate area required for the fill head. After the process is complete, the fill head is removed and the secondary cask lid is installed.

Final closure of all radwaste liners may be accomplished by remote handling equipment, if required. High integrity containers are remotely sealed by a hand manipulated device which screws the closure cap into the liner.

Contamination Control Facilities

An adjacent decontamination area is provided for cleanup of contaminated containers. Exposed surfaces of filled containers or casks are surveyed by the health physics group to identify the presence of removable radioactive contamination prior to transfer to storage or shipment. Containers are decontaminated in the adjacent decontamination area, if required.

Waste Compactors

Two waste compactors are available for use. The one designated for normal use is capable of handling 5,000 lbs. of waste in one compaction. The standby compactor compacts materials into 55 gallon drums.

Normal Use Compactor

An electromechanical compactor with a compressive force capacity of 100,500 lbs. is used to compact dry wastes into a 90 cubic foot container with a filled capacity of 5,000 lbs. During compaction, the container is completely enclosed. A self-contained HEPA filter and blower system filters the air released in the compaction process before any air is discharged to the fuel handling building charcoal exhaust system. An electrical interlock prevents the operation of the compactor if the door which encloses the container is not completely closed. This prevents injury to the operator and unfiltered air from escaping to the hot machine shop atmosphere. This compactor satisfies Occupational Safety and Health Act (OSHA) requirements.

Standby Compactor

An electromechanical compactor, with a compressive force capacity of nine tons, can be used to compact dry wastes into 55 gallon drums. During compaction, the drum is completely enclosed. A self-contained HEPA filter and blower system filters the air released in the compaction process before any air is discharged to the auxiliary building atmosphere. An electrical interlock prevents operations of the compactor if the door, which encloses the drum, is not completely closed. This prevents injury to the operator and unfiltered air from escaping to the auxiliary building atmosphere. This compactor satisfied Occupational Safety and Health Act (OSHA) requirements.

Truck Loading Features

A well penetration is provided between the fill and truck access area to fill directly to containers on a truck. This penetration is located in the shielded cubicle of the solidification area such that exposure in the truck access is limited.

Packaging

Evaporator Bottoms and Chemical Samples

Evaporator bottoms, concentrated to 12 percent, or less, boric acid in the boron recycle or waste evaporator, are stored in the heat traced 5000 gallon waste evaporator concentrates tank. Lines from this tank to the waste line connection in the piping process skid cubicle are also heat traced. Chemical samples are stored in a 600 gallon chemical drain tank. When a sufficient quantity has accumulated in either waste tank, its contents are recirculated for at least two volume changes or until adequately mixed and a sample is taken. The evaporator bottoms sample may be used by the Process Control Program for test solidification. The Chemical Drain Tank sample is used to determined the most appropriate means for disposal.

Spent Resin

Resin in a demineralizer is considered spent when its decontamination factor falls below a permissible level. The spent resin, from demineralizers in the primary system is stored in a 350 ft^3 storage tank. The spent resin from nuclear blowdown demineralizers in the secondary system is stored in a 600 ft^3 nuclear blowdown system storage tank. The resin stored in the primary system is normally allowed to decay for a period of up to several months.

When a sufficient quantity of resin has accumulated and decayed, the resin is sampled, analyzed for isotopic constituents and activities and packaged. Prior to packaging, resin sluice water is recirculated in the tank to form a slurry which is transferred to the liner by nitrogen cover gas pressure. Dewatering of the resin is accomplished using dewater equipment with the water being returned either to the Excess Liquid Waste Holdup Tank, the Decon Pit Collection Tank, or the Floor Drain Tank. Spent resin may also be solidified.

The radiation level of the primary resin is expected to require use of a 4 inch lead shield on some occasions. The radiation level of the nuclear blowdown system resin is expected to require not more than 1½ inch lead shield.

The primary spent resin storage tank has a two inch discharge line located along the tank center line, protruding from its top and extending to within 3 inches above the dished bottom. In preparation for packaging, the discharge valve is opened and the center discharge tube cleared by backflush with a burst of flush water from the reactor makeup water system. Pressure to 100 psig is available, if required. Flush water may continue to be added if needed to obtain a reasonable slurry. The discharge valve is then closed. Loosening of the resin is achieved by introducing nitrogen through seven spargers to loosen the resin if desired. Resin sluice water can be recirculated through the spargers to loosen the resin if desired. When the nitrogen pressure increases to that required for resin transfer, the resin discharge valve is opened. Nitrogen continues to bubble through the resin bed to maintain a gas pressure for transfer of the resin until the liner reaches the full level. The liner vent during this operation is directed to the plant vent or to a portable ventilation unit.

The nuclear blowdown system spent resin storage tank is discharged by use of a procedure similar to that used for the primary spent resin storage tank. The resin slurry is discharged through a 2 inch nozzle located at the tank bottom. Prior to discharge, this line is flushed with resin sluice water or demineralized water. When a resin and water slurry is established within the tank, nitrogen gas is bubbled into the tank bottom connection to loosen and mix the resin and pressurize the tank. When the tank gas pressure increases to that required for resin transfer, the resin slurry discharge valve is opened. Operation of both tanks from this point is similar.

When the transfer is complete, the resin discharge and nitrogen supply valves are closed and a tank vent valve is opened to discharge the nitrogen cover gas from the storage tank. In addition, the flush water supply valve is opened to backflush and forward flush and decontaminate the resin transport line.

Filter Disposal

Filters are of the disposal cartridge type contained in housings having hinged tops. They are replaced when surface dose rate or pressure drop exceeds established levels. Filters which are potentially radioactive are located in individual cubicles in an area close to the drumming station area. If the radiation level of the cartridge requires shielding during removal, a concrete plug in the floor above the housing is removed and another plug with a hole in it is placed in the stepped opening. A filter cask with 3½” lead encased in stainless steel is placed over the hole. The filter housing is opened and the cartridge is drawn into the cask by the use of special tools having extension rods. Once the filter is in place, the cask bottom is closed and the tops installed. The cask is then transported by an overhead crane to a hatch at floor elevation 463' of the auxiliary building. This hatch is located above the drumming station area on the floor below. The cask is lowered into the drumming station area. Storage and disposal of all filters is within either high integrity containers or DOT approved containers depending on the specific activity of the filters. For filters requiring shielding, the container is stored in a shielded cask. The filter transfer cask is positioned over a small opening in the shield cask, the bottom slide is pulled open, and the filter is lowered into the shielded container. In this manner, the handling of highly contaminated filters is kept to a minimum.

Radioactive Hardware

Radioactive hardware can consist of damaged or used equipment or instruments, which due to geometry or materials of fabrication, cannot be readily decontaminated. Such material is disposed of in much the same way as are filter cartridges or as compacted waste, depending upon radiation levels.

Compacted Wastes

Compressible solid waste is compacted by an electromechanical compactor capable of 100,500 lbs. force into 90 cubic foot containers, each with a filled capacity of 5,000 lbs. A standby compactor which also is an electromechanical device compacts materials into 55 gallon drums.

Normal Use Compactor

An electromechanical compactor provides 100,500 lbs. of compressive force for the compaction of compressible waste into 20 cubic foot containers. During compaction the container and compacting mechanism are enclosed and the enclosure is vented to the fuel handling building charcoal exhaust system through a HEPA filter by a blower. The blower and facility are contained within the compactor. The blower is automatically operated when the door is closed; however, a manual switch is provided so the blower may be operated without compactor operation. The compactor conforms to current OSHA requirements. The compactor will not operate unless the door is closed, protecting the operator from injury and preventing escape of unfiltered air to the atmosphere.

Standby Compactor

An electromechanical compactor provides nine tons of compressive force for the compaction of compressible waste into 55 gallon drums. During compaction the drum and compacting mechanism are enclosed and the enclosure is vented to the auxiliary building atmosphere through a HEPA filter by a blower. The blower and filter are contained within the compactor. The blower is automatically operated when the door is closed; however, a manual switch is provided so the blower may be operated without compactor operation. The compactor conforms to current OSHA requirements. The compactor will not operate unless the door is closed, protecting the operator from injury and preventing escape of unfiltered air to the atmosphere.

D. STORAGE

Compactable waste, filled containers of compacted waste, and spent filter cartridges are stored in the shielded areas of the radwaste area or in a location determined by the Manager of Health Physics and Radwaste Services. Contaminated hardware and tools may also be stored in these rooms. Solidified waste, after solidification is complete, and dewatered resins, once dewatering is complete, may be shipped off-site for immediate burial at a licensed facility. Primary spent resins will normally have at least a one month decay period while being held in the spent resin storage tank. Evaporator bottoms and secondary blowdown resins do not normally require a decay period.

If solidified waste and/or dewatered resins require storage for any reason, they will be stored in the radiation control area outside the truck access on the storage pad or in a location determined by the Manager of Health Physics and Radwaste Services. The storage pad is approximately 40 feet wide by 120 feet and is sloped toward a hold-up trench. Waste stored in the storage area will be shielded as required by portable shields and/or casks used for shipment.

Storage areas for solidified waste, dewatered resins, and compacted waste are sufficient to accommodate greater than 30 days waste generation.

E. SHIPMENT

Shipment, in accordance with applicable regulations, is made as necessary -- dependent upon operational considerations and storage area availability.

The primary activity determination method will be to sample the waste stream (resins and liquid waste) during transfer to a process container and analyze the sample using the appropriate counting instrumentation. An isotopic determination is made of the radionuclides present and the activity of each. Summation of the individual activities is used to calculate the Curie content of the processed container.

For cases where the primary method cannot be used, an alternate technique will be implemented. The alternate method entails using the dose rate of the packaged waste in order to calculate the Curie content. The calculation considers the waste characteristics, geometry of the waste package, characteristics of the container and solidification media (if applicable), and the average gamma energy. For spent cartridge filters, this alternate method will be used to determine the Curie content. The appropriate counting instrumentation is used to analyze samples taken from the process stream to identify radionuclides present and the average gamma energy.

Potential for Releases

During Container Filling

The filling operation may be terminated via visual inspection using a remote monitor/television camera. Termination is accomplished by closing valves MOV-2 and MOV-5.

There is no airborne release to the atmosphere in the fill areas. Air in the container and gas, if any, from the waste entering the container are vented to the building exhaust, through a local filter, or through a portable ventilation unit. Only one line feeds waste to the container. This is flushed with water as the final phase of the fill cycle.

If leaks of any kind or spills are observed, the operation in progress can be immediately terminated. Any spill which may occur will be contained by permanent curbing in the solidification area.

Except for the curb in the solidification area, there are no physical barriers in the immediate fill areas to contain spills. Spills from the shipping container would need to be drained to a specific location or container as determined by the type of material spilled.

The floor surfaces have a special nonporous finish to permit decontamination of the surface, if required.

Release from Storage Tanks

Evaporator Tank

Essentially all radioactive gases are stripped from the concentrates in the waste evaporator. A normally closed vent is ducted to the auxiliary building exhaust system. A water seal, set for 2 feet of water, vents to the waste evaporator concentrates tank cubicle which is serviced by the auxiliary building exhaust system.

Overflow is not anticipated since waste evaporator concentrates tank capacity is sufficient for storage of the expected volume of concentrates generated by one year of normal operation. However, an overflow is directed to the waste holdup tank. Level indicators actually alarms at the solid waste system control panel prior to tank overflow.

Floor drains in the cubicles for this tank and for the waste evaporator concentrates tank transfer pump drain to the floor drain tank. By appropriate venting, the concentrates can be pumped from the floor drain tank to either the waste holdup tank, waste evaporator, waste evaporator concentrates tank, or directly to the drumming station area for solidification.

Chemical Drain Tank

This tank is vented to the building exhaust system. A high level alarm is provided on the solid waste system control panel. Overflow, or leakage, if it occurs, is directed to the auxiliary building sump by a floor drain. The liquid is pumped from this sump to the floor drain tank which is at the same floor elevation as the chemical drain tank.

Primary Spent Resin Storage Tank

This tank contains only a negligible quantity of radioactive gases in the gas space. The gas is normally contained in the tank by a closed vent valve. This vent is ducted to the auxiliary building exhaust system and is open only during transfer of resin from the demineralizers or at the conclusion of transferring resin from this tank to the radwaste packaging area.

Overflow is not anticipated since primary spent resin storage tank capacity is sufficient to accommodate at least 60 days waste generation under normal plant operating conditions. Overflow protection is provided by a high level alarm at the solid waste system control panel. Excess water can either be pumped or drained to the waste holdup tank. Overflow, if it occurs, is to the waste holdup tank through a relief valve.

The tank is enclosed within a concrete cubicle with entrance from an overhead shield slab. Any leakage is directed to the floor drain tank through a floor drain.

Nuclear Blowdown Spent Resin Storage Tank

This tank contains only trace amounts of radioactive gas. The gas is normally contained in the tank by a closed vent valve. The tank is vented to the cubicle, which is serviced by the building exhaust system, only during transfer of resin from the demineralizers or at the conclusion of resin transfer from this tank to the radwaste packaging area.

Overflow is not anticipated since the nuclear blowdown spent resin storage tank capacity is sufficient to accommodate at least 30 days waste generation under normal plant operating conditions.

Overflow protection is provided by a high level alarm at the solid waste system control panel. Excess water can either be pumped or drained to the nuclear blowdown system reservoir. Overflow, if it occurs, is to the nuclear blowdown system reservoir through a relief valve.

The tank is enclosed within a concrete cubicle with entrance from an overhead shield slab. Any leakage is directed to the nuclear blowdown system reservoir through a floor drain.

F. WASTE OIL INCINERATION

Disposal of slightly contaminated lubricating oils may be performed using on-site incineration. The waste oil incinerator is located outside the protected area, approximately 2,500 feet southwest of the Reactor Building. Access to the incinerator is controlled through station health physics.

Incinerator ash will be handled as dry active waste (DAW) and disposed of in accordance with 10 CFR 20.301 at an NRC licensed facility.

Gaseous effluent controls for incineration of oil will be established, as follows, such that gaseous release from all station pathways, including on-site oil incineration, will be maintained less than limits specified in 10 CFR 20, Appendix B, Table 2, Column 2 and 10 CFR 50, Appendix I. Incinerator gaseous effluent will be assessed, prior to incinerating each oil batch, by comparing projected offsite dose rates and doses to applicable Offsite Dose Calculation Manual (ODCM) specification release limits. If prerelease projections exceed 1% of the applicable limits, all plant effluents will be reviewed to ensure that the combination of gaseous effluents from oil incineration and plant gaseous effluents will not cause applicable release limits to be exceeded.

The quantity of radioactive gaseous effluent and solid waste (ash) released as a result of on-site oil incineration, along with an assessment of offsite dose, will be reported in the Regulatory Guide 1.21 effluent release report. Offsite dose will be calculated using methodology described in the Offsite Dose Calculation Manual.

2.6.2.7 Watts Bar 1

A. LIQUID WASTE SYSTEMS

Design Objectives

The Liquid Waste Processing System is designed to receive, segregate, process, and discharge liquid wastes. The system design considers potential personnel exposure and assures that quantities of radioactive releases to the environment are as low as reasonably achievable. Under normal plant operation, the activity from radionuclides leaving the cooling tower blowdown line is a fraction of the limits in 10 CFR Parts 20 and 50.

Systems Descriptions

The Liquid Waste Processing System collects and processes potentially radioactive wastes for release to the river. Provisions are made to sample and analyze fluids before they are discharged. Based on the laboratory analysis, these wastes are either released under controlled conditions via the cooling tower blowdown or retained for further processing. A permanent record of liquid releases is provided by analyses of known volumes of waste.

The bulk of the radioactive liquids discharged from the reactor Coolant System are processed by either the Chemical and Volume Control System (CVCS) holdup tanks or Tritiated Drain Collector Tank (TDCT).

The liquid Waste Processing System (WPS) consists of two main sub-systems processing tritiated and non-tritiated water. A system is provided for handling laboratory samples which may be tritiated and may contain chemicals. Capability for handling and storage of spent demineralizer resins is also provided.

Much of the system is controlled or monitored from a central panel in the Auxiliary Building. Malfunction of the system actuates an alarm in the Auxiliary Building. All system equipment is located in or near the Auxiliary Building, except for the reactor coolant drain tank and drain tank pumps; containment pit sump and pumps; Reactor Building floor and equipment drain sump and pumps; Reactor Building floor and equipment drain pocket sump and pumps, which are located in the Reactor Building. A mobile demineralizer system is located and operated in the waste packaging area.

Fluid is sampled and analyzed in the respective segregated systems to determine quantities of radioactivity, with an isotopic breakdown, if necessary, before processing or disposal is attempted.

Operating Procedure

The equipment installed to reduce the activity of radioactive effluents is maintained in good operating order and is operated to as low as reasonably achievable criteria, as stated in the ODCM. In order to assure that these conditions are met, administrative controls are exercised on overall operation of the system; preventive maintenance is utilized to ensure equipment is in optimum condition; and applicable industry experience and vendor information available is used in planning for operation at Watts Bar Nuclear Plant.

Administrative controls are exercised through the use of instructions covering such areas as valve alignment for various operations, equipment operating instructions, and other instructions pertinent to the proper operation of the processing equipment. Discharge permits are utilized to assure proper procedures are followed in sampling and analyzing any radioactive liquid to be discharged and in assuring proper valve alignments and other operating conditions before a release. These permits are signed and verified by those personnel performing the analysis and approving the release.

Preventive maintenance is performed in accordance with approved plant maintenance program procedures developed, considering applicable operating and maintenance experience as well as vendor information.

Operation of the Liquid Waste Processing System is essentially the same during all phases of normal reactor plant operation; the only differences are in the load on the system. The following sections discuss the operation of the system in performing its various functions. In this discussion, the term "normal operation" should be taken to mean all phases of operation except operation under emergency or accident conditions. The Liquid Waste Processing System's only primary safety function is containment isolation.

Liquid Waste Processing

Normal Operation

During normal plant operation the system processes liquid from the following sources:

1. Equipment drains and leaks
2. Radioactive chemical laboratory drains
3. Radioactive laundry and shower drains
4. Decontamination area drains
5. Demineralizer flushing, backwashing and regeneration of resin
6. Sampling system

The system also collects and transfers liquids from the following sources directly to the reactor coolant drain tank for processing in the CVCS.

1. Reactor coolant loops
2. Pressurizer relief tank
3. Reactor coolant pump secondary seals
4. Excess letdown during startup
5. Accumulators
6. Valve and reactor vessel flange leakoffs
7. Refueling canal drains

The liquid flows to the reactor coolant drain tank and is discharged directly to the CVCS holdup tanks by the reactor coolant drain pumps which are operated automatically by a level controller in the tank. These pumps can also return water from the refueling cavity to the refueling water storage tank. There is one reactor coolant drain tank with two reactor coolant drain pumps located inside the containment of each unit.

Normally, the reactor coolant drain pumps are operated in the automatic mode, which allows pump operation and reactor coolant drain tank level to be controlled. The pumps can also be operated manually to control the tank level.

Where possible, waste liquids drain to the waste disposal system flow and tritiated drain collector tanks by gravity flow.

Separation of Tritiated and Non-tritiated Liquids

Waste liquids which are high in tritium content are routed to the tritium drain collector tank, while liquids low in tritium content are routed to the floor drain collector tank. The tritiated and non-tritiated liquids are processed for release to the river.

- Tritiated Water

Tritiated water enters the liquid waste disposal system via equipment leaks and drains, valve leakoffs, pump seal leakoffs, tank overflows, and other tritiated and aerated water sources.

The tritiated liquids from equipment leaks and drains, and valve leak-offs which are below the tritiated drain collector tank, are drained to the sump and are pumped from there to the tritiated drain collector tank. Normally, the sump pumps are operated in the automatic mode, which allows tank level to the be controlled. The pumps can also be operated manually.

The liquid collected in the tritiated drain collector tank contains boric acid and fission product activity. The liquid collected is normally demineralized by the mobile waste demineralizer or can be evaporated in the CDWE (not required for Unit 1 operation) and is then analyzed and discharged to the river.

- Non-tritiated Water

Non-tritiated water sources include floor drains, equipment drains containing non-tritiated water, certain sample rooms and radiochemical laboratory drains, laundry and hot shower drains and other non-tritiated sources.

The liquids entering the floor drain collector tank are primarily from low activity sources. The liquid collected is normally demineralized by the mobile waste demineralizer or can be evaporated in the CDWE (not required for Unit 1 operation) and is then analyzed and discharged to the river.

Laundry and Hot Shower Drains

One of the two laundry and hot shower tanks is valved to receive waste at all times. When one tank is filled, it is valved out and the other tank is valved in. The full tank is then aligned with the laundry pump to mix the waste by recirculation. A sample is taken from a local sample connection to determine what subsequent handling of the waste liquid is required. Normally no treatment is required for removal of radioactivity. This water is transferred to either cooling tower blowdown (CTBD) or floor drain collector tank (FDCT) via the laundry tank strainer or to Cask Decontamination Collector Tank (CDCT) via the waste condensate filter. A sample is taken and, after analysis, the water is discharged if the activity level is below acceptable limits. Low sudsing cleaning agents are used to minimize foaming.

Laboratory Samples

Laboratory samples which contain chemicals used in analysis are normally discarded in a fume hood sink which drains to the chemical drain tank.

The operation of the chemical drain tank pump and control of the tank level is manual, with the exception that the pump is shut off automatically on low tank level.

Low activity drains from the laboratory, such as flush water, are normally routed to the floor drain collector tank. Excess tritiated samples not contaminated by chemicals during analysis are normally directed to the tritiated drain collector tank.

Shipping Cask Decontamination Drains

Liquid used to decontaminate the spent fuel shipping cask is drained to the 15,000 gallon cask decontamination collector tank. The liquid is expected to be low enough in radioactivity content that it can be discharged without processing other than by filtration. Following analysis, the liquid is pumped through the cask decontamination filter and is discharged. In the unlikely event that the radioactivity level is such that further processing is required, the liquid is transferred to the floor drain collector tank for processing through the Mobile Waste Demineralizer System or the Condensate Demineralizer Waste Evaporator.

Condensate Polishing Demineralizer Waste

The CPDS regeneration subsystem is designed to separate wastes into two fractions - one, a high crud, low-conductivity liquid; and the other, a low-crud, high-conductivity liquid. These fractions are collected in separate tanks. The first fraction results from backwash which precedes chemical regeneration and from rinses which follow chemical regeneration. The second fraction consists of neutralized chemical regenerants plus displacement water. At each regeneration, the volume of the first fraction is about 23,000 gallons, and that of the second fraction is about 10,000 gallons.

Treatment of High-Crud, Low Conductivity (HCLC) Waste

The high-crud waste is normally low in conductivity. This waste is processed in equipment located in the Turbine Building. The slurry is filtered in the HC pre-filter or HC filter. The filtrate radioactivity is low enough to achieve adequate dilution in the cooling tower blowdown, in accordance with the ODCM, and is normally discharged. If the waste can not be properly diluted, it can be routed to the waste disposal for further processing. Following a filter run in the HC filter, the filter is backwashed and the liquid is routed to the HC tank.

Treatment of Low-Crud, High-Conductivity (LCHC) Waste

The LCHC wastes, consisting of the spent regeneration chemicals is neutralized in a neutralizer tank and is normally transferred to a non-reclaimable waste tank. The liquid is normally processed by the condensate demineralizer waste evaporator (not required for Unit 1 operation). Alternatively, it may be transferred to the floor drain collector tank for processing with the other radwaste or to vendor supplied equipment for further processing. However, the liquid is circulated and sampled prior to processing. If the radioactivity level is below permissible discharge levels, it may be discharged directly without further treatment.

Discharge of Regeneration Wastes

Waste liquids from the condensate polishing demineralizer regeneration that are to be discharged are first sampled and analyzed to ensure that the activity level complies with requirements stated in the ODCM. The discharge line from the Turbine Building extends to the cooling tower blowdown line, and includes a locked-closed valve, a radiation monitor, and a radiation-controlled valve. The latter is arranged to close on a high radiation signal from the monitor. It is closed also by a signal from the flow meter in the cooling tower blowdown line on low flow, indicating inadequate dilution flow.

Spent Resin Handling

This portion of the system sluices resin from the demineralizers and transports resin from the spent resin storage tank to the railroad access bay to be dewatered or solidified by an offsite contractor.

CVCS Resin Sluicing

Spent resins are initially fluidized by backflushing with primary water. The backflush water is routed to the tritiated drain collector tank.

The resin is then drained and flushed to the spent resin storage tank. Fresh resin is then added and the demineralizer is filled with water, as a cover, over the resin. The valves are then realigned for normal process operation. A negligible amount, if any, of resin is expected to remain in a demineralizer after flushing, as the demineralizers are completely flushable.

Releases of Waste

Release of radioactive liquid out of the Liquid Waste Processing System is from the waste condensate tanks, cask decontamination collector tank, CVCS monitor tank, chemical drain tank, and laundry and hot shower tank to the blowdown line from the cooling towers. The cooling tower blowdown line discharges into the river through the diffuser pipes. Liquid wastes from the condensate polishing demineralizer system are released from the high-crud tanks, the non-reclaimable waste tank, and condensate demineralizer waste evaporator distillate tanks (not required for Unit 1 operation).

The condenser circulating water system operates in the closed cycle mode. Water is recirculated between the cooling towers and the condenser. The cooling towers blowdown flows to the diffuser in order to maintain the solids in the water at an acceptable level.

Release of the radioactive liquids from the liquid waste system is made only after laboratory analysis of the tank contents. If the activity is not below ODCM limits, the liquid waste streams are returned to waste disposal system for further processing by the mobile demineralizer. Once the fluids are sampled, they are pumped to the discharge pipe through a normally locked closed manual valve and a remotely operated control valve, interlocked with a radiation monitor and a flow element in the cooling tower blowdown line. This assures that sufficient dilution flow is available for the discharge of radioactive liquids. The minimum dilution flow required for discharge of radioactivity into the cooling tower blowdown lines (CTBL) is 20,000 gpm.

A similar arrangement is provided for wastes discharged from the condensate polishing demineralizer waste system. A radiation monitor on this system and a flow element on the cooling tower blowdown are interlocked with a flow control valve in the system discharge line. Release of wastes is automatically stopped by either a high radiation signal or a signal which indicates that inadequate dilution flow is available.

The steam generator blowdown system also may discharge radioactive liquid. Liquid waste from this system is not collected in tanks for treatment, but is continuously monitored for radioactivity and may discharge to the cooling tower blowdown, or recirculated to the condensate system upstream of the condensate demineralizers. Refer to Section 10.4.8 for a description of the steam generator blowdown system operation and/or 11.4.2.1.4 for a description of its monitoring system.

The turbine building sump collects liquid entering the turbine building floor drain system. When the sump is nearly full (approximate usable capacity of 30,000 gallons), the liquid is pumped to either the low volume waste treatment (LVWT) pond or the yard holding pond. Water in the ponds overflows and drain by gravity to the river via the cooling tower blowdown line to the diffusers. If high concentrations of chemicals are present, it may be pumped to the lined or unlined metal cleaning waste ponds for treatment before release per the NPDES Permit.

B. GASEOUS WASTE SYSTEMS

Design Bases

The Gaseous Waste Processing System (GWPS) is designed to remove fission product gases from the Nuclear Steam Supply System and to permit operation with periodic discharges of small quantities of fission gases through the monitored plant vent. This is accomplished by internal recirculation of radioactive gases and hold up in the nine waste gas decay tanks to reduce the concentration of radioisotopes in the releases gases.

The plant gaseous effluent releases during normal operation of the plant are limited at the site boundary not to exceed 10 CFR 50 Appendix I and 40 CFR 190 limits are specified in the Offsite Dose Calculation manual (ODCM).

SYSTEM DESCRIPTIONS

The Gaseous Waste Processing System (GWPS) consists of two waste gas compressor packages, nine waste gas decay tanks, and the associated piping, valves and instrumentation. The equipment serves both units.

SYSTEM DESIGN

Waste Gas Compressors

The two waste gas compressors are provided for continuous removal of gases discharging to the vent header. One unit is supplied for normal operation and is capable of handling the gas from a holdup tank which is receiving letdown flow at the maximum rate. The second unit is provided for backup during peak load conditions, such as when degassing the reactor coolant or for service when the first unit is down for maintenance. Operation of the backup unit can be controlled manually or automatically by vent header pressure. Each unit is sized for 40 CFM. The compressors are of the water sealed centrifugal type and are provided with mechanical seals to minimize leakage. Construction is of cast iron external and bronze internals with a stainless steel shaft.

Gas Decay Tanks

Nine tanks are provided to hold radioactive waste gases for decay. This arrangement is adequate for a plant operating with one percent fuel defects. Nine tanks are provided so that during normal operation, a minimum of 60 days are available for decay.

The tanks are vertical cylindrical type and are constructed of carbon steel.

Operating Procedure

Equipment installed to reduce radioactive effluents to the minimum practicable level will be maintained in good operating order and will be operated to the maximum extent practicable. In order to assure that these conditions are met, administrative controls are exercised on overall operation of the system; preventive maintenance is utilized to maintaining equipment in optimum condition; and experience available from similar plants is used in planning for operation at Watts Bar Nuclear Plant.

Administrative controls are exercised through the use of instructions covering such areas as valve alignment for various operations, equipment operating instructions, and other instructions pertinent to the proper operation of the processing equipment. Discharge permit forms are utilized to assure proper procedures are followed and in assuring proper valve alignments and other operating conditions before a release. These forms are signed and verified by those personnel performing the analysis and approving the release.

Preventive maintenance is carried out on all equipment as described in the plant's maintenance program.

Gaseous wastes consists primarily of hydrogen stripped from the reactor coolant during boron recycle (not required for Unit 1 operation) and degassing operations and nitrogen from the closed cover gas system. The components connected to the vent header are limited to those which normally contain no air or aerated liquids to prevent formation of a combustible mixture of hydrogen and oxygen.

Waste gases discharged to the vent header are pumped to a waste gas decay tank by one of the two waste gas compressors which operates continuously.

The standby compressor is stated automatically when high pressure occurs in the vent header. The standby compressor can be started manually. The compressors may also be used to transfer gas between gas decay tanks.

To compress gas into the gas decay tanks, the operator selects two tanks at the auxiliary control panel, one to receive gas, and one for standby. When the tank in service is pressurized to 100 psig, flow is automatically switched to the standby tank and an alarm alerts the operator to select a new standby tank.

The decay tank being filled is sampled automatically by the gas analyzer and an alarm alerts the operator to a high oxygen content. On high oxygen signal, the tank must be isolated and operator action is required to direct flow to the standby tank and to select a new standby tank.

If it should become necessary to transfer gas from one decay tank to another, the tank to be emptied is discharged to the holdup tank return line. The tank to receive gas is opened to the inlet header and the return line pressure regulator set point is raised to above 1.8 psig. The return line isolation suction is opened. With this arrangement, gas is transferred by the compressor which is in service.

As the Chemical and Volume Control System holdup tanks' liquid is withdrawn for processing by the boric acid evaporator (not required for Unit 1 operation), gas from the gas decay tanks is returned to the holdup tanks. The gas decay tank selected to supply the returning cover gas is attached to the return header from the auxiliary control board by manually opening the appropriate valve.

To maximize residence time from decay in the decay tanks, the last tank filled is the first tank attached to the header. A backup supply of gas for the holdup tanks is provided by the nitrogen header.

Before a gas decay tank is discharged to the atmosphere via the plant vent, a gas sample is taken to determine activity concentration of the gas and total activity inventory in the tank. The sample is taken by inserting a sample vessel in the gas analyzer's vent bypass line. Flow through the vessel is established by manually actuating the gas decay tank "manual select" sample station. When sufficient time has elapsed for a volume to be collected the gas analyzer is returned to normal alignment and the sample is removed for analysis. Total tank activity inventory is determined from the activity concentration and pressure in the tank.

To release the gas, the appropriate local manual stop valve is opened to the plant vent and the gas discharge modulating valve is opened at the auxiliary control panel. The plant vent activity level is also indicated on the panel to aid in setting the valve properly. If there should be a high activity level in the vent during release, the modulating valve closes.

C. SOLID WASTE MANAGEMENT SYSTEM

Design Objectives

The slurries and solid radwaste (including resin waste) produced by WBN Units 1 and 2 is prepared for shipment or for temporary on-site storage in compliance with the requirements in 10 CFR 61, 10 CFR 71, and 49 CFR 171, 172, 173, 177, and 178. Solid wastes are processed by the solid waste system (SWS) which is located in a seismic Category I structure. The waste packaging area, divided into three sections by thick concrete walls is composed of the mobile demineralizing (MD) area, an area for high level storage and the MD storage container, and an area for low level dry active wastes (DAW).

System Inputs

Waste inputs are divided into two categories: (1) Dry Active Waste (DAW) and (2) Wet Active Waste (WAW). DAW and WAW are products of the plant operation and maintenance. DAWs are further subdivided into Compactable and noncompactable wastes. Solid Compactable wastes include paper, clothing, rages, mop heads, rubber boots, and plastic. Non-Compactable wastes include tools, mop handles, lumber, glassware, pumps, motors, valves, and piping.

Wet active wastes are primarily composed of spent resins. The sources for spent resins are the spent resin storage tank, the mobile demineralizer, and Condensate Polisher Demineralizer System (CPDS).

A list of inputs and expected yearly volumes of solid wastes are provided in Table 11.5-1. Table 11.5-2 provides a list of major nuclides activity to be shipped on a yearly basis.

Systems Description

Wet Active Waste Handling - Spent Resin Processing

A system for packaging and dewatering bulk quantities of spent resin for shipment is shown in Figure 11.5-1 of the FSAR. The shipping container consists of an inner disposable steel liner with an outer returnable shield. Filter elements are mounted inside the liner near the bottom and are connected to a hose connection outside the shield to facilitate dewatering spent resins. The container also has fill and vent connections.

Several types of shipping casks may be used. Most of these are vertical cylinders, having capacities of 128 ft^3 to 215 ft^3. All casks have been licensed pursuant to the general license provisions of paragraph 71.12(b) of 10 CFR part 71. Other licensed casks are available to TVA on a rental basis.

Loading is accomplished with the cask mounted on a truck or trailer bed. The truck or trailer is located in the Auxiliary Building railroad bay. The cask with disposable liner is filled from the spent resin tank. The spent resin storage tank is pressurized with nitrogen, and the resin slurry is sluiced to the liner using water from the primary makeup water (PMW) System. Water is removed from the liner through the internal filters, and is collected in the tritiated drain collector tank. A pump is used as required to aid the dewatering process. Additional slurry is added to the container, and the fill-and-dewatering process is repeated until the level indicator shows that the desired amount of resin had ben transferred. The waste is dewatered to meet the free-standing water limitations at licensed disposal facilities, and the liquid effluent is discharged to the tritiated drain collector tank. Flush connections are provided from the PMW System to flush the resin slurry lines back to the spent resin storage tank.

The resins are sampled for waste characterizations per 10 CFR 61. The high integrity containers (HIC) are capped and may be temporarily stored at the site prior to shipment. Temporary on-site storage is provided in the yard east of the CDWE Building and in the Auxiliary Building railroad bay. Primary spent resins are stored only in a shielded container if stored in the yard.

In the event that the container were to overflow during the filling process, the overflow would take place through the vent line and the liquid would drain to the tritiated drain collector tank. The strainer in the vent line would prevent overflow of resin.

In certain cases spent resins will be stabilized or packaged in a HIC. Resins can also be transferred to a commercial portable solidification unit for solidification (see Section II.5.4.2).

Spent Resin Inventory

The level indicating system in the spent resin storage tank is a thermal disposition type level probe which measures resin and water level independently. Since the level probe indicates the resin/water interface, the inventory of spent resins in the tank can be determined.

Mobile Demineralizer Resin Processing

Spent resins from the mobile demineralizer system are stored in a vendor-supplied container to accumulate sufficient resins for disposal off-site. Loading is accomplished with the cask mounted on a truck or trailer bed located in the Auxiliary Building railroad bay. The cask with the disposable liner/HIC is filled from the vendor furnished storage containers. Resin slurry is sluiced to the liner using water. Water removed from the liner through the internal filters is discharged to the tritiated drain collector tank, and a pump is used as necessary to aid the dewatering process. Additional slurry is added to the container, and the fill-and-dewatering process is repeated until the level indicator shows that the desired amount of resin has been transferred. The waste is dewatered to meet the free-standing water limitations at licensed disposal facilities.

The resins are sampled for waste characterization per 10 CFR 61. The liners/HICs are capped and may be temporarily stored at the site prior to shipment. Temporary on-site storage is provided in the yard east of the CDWE Building and in the Auxiliary Building railroad bay. Spent mobile demineralizer resins are stored only in a shielded container if stored in the yard.

Condensate Polishing Demineralizer Resin Processing

Contaminated spent resins from the condensate polishing demineralizer system are transferred directly from the storage tank to a disposal liner located on a trailer in the Turbine Building railroad bay. The resin storage tank is pressurized with air, and the resin slurry is sluiced to the liner using water from the condensate system. Water is removed from the liner through internal filters, and is collected in the high crude tanks. Additional slurry is added to the container, and the fill-and-dewatering process is repeated until the level indicator shows that the desired amount of resin has been transferred. The waste is dewatered to meet the free-standing water limitations at licensed disposal facilities or licensed waste processors. The resins are sampled for waste characterization per 10 CFR 61. The liner is capped and may be provided in the yard east of the CDWE Building and in the Auxiliary Building railroad bay. Yard storage is permitted provided the resins are in the final disposal/shipping containers.

Dry Active Waste Handling

Dry active waste (DAW) is separated into two types of waste. The two types of waste are those that can be incinerated (incinerable), and those that cannot be incinerated (non-incinerable). DAW is collected throughout the plant and is brought to the waste packaging area. Here DAW is sorted and temporary stored prior to shipment offsite.

- Incinerable Waste

Incinerable waste like paper, clothing, rags, plastic, mop handles, lumber, etc., are collected and then transferred to a Sealand type container for processing by offsite vendor and disposal.

- Non-incinerable Waste

Non-incinerable waste such as tools, valves, motors, etc., are collected and packaged in containers, and are temporary stored. This waste is then sent for processing by an offsite vendor for volume reduction, and disposal or recycle.

Miscellaneous Waste Handling

Air and gas filter and prefilter elements and glassware are placed in appropriate containers. Wet radioactive plant filters are packaged, when necessary, in high integrity containers.

If radiation levels of containers are high enough to require shielding, they are loaded into and transported in shielded truck trailers or a cask similar to those used to transport liners containing bulk quantities of dewatered resins.

Mobile Solidification System (MSS)

The MSS is a portable solidification unit provided by a vendor service contract. The MSS combines and mixes radioactive wastes (resins, concentrates and liquid wastes) with solidification agents and needed additives to solidify the waste. The solidification is done in accordance with a Process Control Program to ensure that each batch of waste is properly solidified. Only solidification agents (such as cement) which have been approved by licensed disposal facilities are used. The waste is solidified in a disposal liner and prepared for shipment or temporary on-site storage. The disposable liners are equipped with internal mixers to prove uniform mixing. The mobile solidification system is located in the Auxiliary Building railroad bay. Necessary connections have been provided in the railroad bay to support the mobile solidification system as shown by Figure 11.5-1 of the FSAR.

D. STORAGE FACILITIES

- Inplant Storage Areas

Packaged wastes and unpackaged dry active wastes are stored in designated storage areas until shipment. Designated inplant storage areas include the waste packaging area and the Auxiliary Building railroad bay. The indoor storage for processed wastes and unprocessed DAW provides greater than 30-day storage at expected generation rates. For unprocessed wet wastes the following storage containers are provided:

Spent Resin Storage Tank	300 ft^3
Mobile Demineralizer Storage Container	267 ft^3

CPDS Storage Tank	441 ft^3
Filter HIC/shielding	96 ft^3

The above unprocessed storage capacities provide greater than 30 days storage at expected generation rates.

- Outside Radwaste Storage

Operational considerations make it necessary to temporarily store containers of radioactive materials and radioactive wastes in designated areas such as the east yard outside of the CDWE. Liners of dewatered resin are stored the same as other containers such as drums or boxes. Drums, boxes, and liners of radioactive materials or wastes may be stored in outside storage areas after being packaged for shipment or storage. The outside storage yard provides sufficient storage to accommodate one full shipment of DAW or radioactive materials. The contact dose for containers stored outside is in accordance with 49 CFR 173.441.

E. SHIPMENT

Waste is shipped to a commercial disposal site according to federal regulations and disposal site criteria. Waste may also be shipped to a broker/processor to meet federal regulations and disposal site criteria. Drums and boxes containing radwaste are transported to the disposal facility in a sole-use van-type or flatbed truck trailer. Dewatered resins and solidified resins are packaged in liners or HICs and transported in a transportation cask when required. Radioactive waste is packaged and transported in accordance with federal, state and TVA regulations.

2.6.2.8 Fermi 2

A. LIQUID RADWASTE SYSTEM

The liquid radwaste system collects, monitors, processes, stores, and returns radioactive liquid wastes to the plant for reuse, or to the circulating-water reservoir blowdown line for controlled discharge. The collection and processing are done in a controlled, preplanned manner in compliance with established regulatory requirements. Any leakage or spillage due to equipment failure or malfunction will be contained and recollected in the system. The system is capable of handling anticipated quantities of liquid radwaste without affecting the normal operation or availability of the plant.

Design Objectives

The liquid radwaste system is designed to function as follows:

a. Produce effluents that meet the limits of 10 CFR 20 and the design objectives of 10 CFR 50, Appendix I

b. Control and monitor releases of radioactive materials to the environment per the requirements of 10 CFR 50, Appendix A, General Design Criteria (GDC) 60 and 64

c. Produce treated waste of condensate quality for reuse within the plant

d. Provide the capacity to process liquid radioactive wastes produced in the plant during normal operation and during anticipated operational occurrences

e. Handle anticipated quantities of liquid radwaste without affecting the normal operation or availability of the plant

f. Segregate wastes into subsystems for more efficient processing

g. Provide alternative methods and redundancy of major items of equipment for processing radioactive liquids to ensure the flexibility of operation and maintenance

h. Use the plant drainage system to collect radioactive leakage or spillage due to equipment failure or malfunctions during normal plant operations

i. Provide for the transfer of liquid radwaste system processed waste by-products (evaporator bottoms, filter backwashes, tank sludge letdown, and spent resin) to the solid radwaste system

j. Protect plant personnel from radiation exposure and incorporate the basic as-low-as-reasonably-achievable (ALARA) objectives by the use of automated systems, shielding, and remotely operated instrumentation and controls.

Note: The following description of the Liquid Radwaste System details the as-designed and as-installed design basis system. However, three of the described portions or subsystems remain in place and have-not been isolated by any plant modifications. They (and all components of them) have not officially been retired, abandoned, or disconnected, and they could conceivably become operational at some time in the future. Therefore, the full original design-basis description, usage, and tables for these items has been retained in

Section 11.2 and all other pertinent sections of this UFSAR. These statements describing the system design are all technically correct; however, these items (and therefore their flow paths) are not considered operational at this time. These three subsystems or components are:

1. Radwaste Evaporator and supporting components

2. Two radwaste Etched-Disc Filters and supporting components

3. Two radwaste Oil Coalescers and supporting components

System Description

The liquid radwaste system is composed of two major subsystems -- the floor drain collector (FDC) subsystem and the waste collector subsystem.

At times the liquid radwaste system may produce water that may not be required for reuse in the station's water balance, in which case the system effluent could be discharged in a controlled manner to the circulating-water reservoir blowdown line. Processed liquid not meeting the criteria for either discharge or reuse is normally returned to the system for reprocessing.

The liquid and solid radwaste systems have a number of piping connections for use by portable waste-processing systems. Vendor-contract services are available on-site for waste processing and solidification.

System Design

The liquid radwaste system is designed to ensure that system operation can be accomplished in a safe manner and to minimize the accumulated radiation exposure to system operators. Design practices that result in the achievement of the ALARA philosophy are used throughout. Where appropriate, redundant pump capacity is provided. Shielding is located to protect workers from operating equipment radiation.

The liquid radwaste system is designed to accommodate ease of maintenance in a radiation area, and, to the extent practicable, components are separated by shield walls to reduce radiation exposure to maintenance personnel. Clearance provisions are adequate for in-place maintenance activities and for the removal or replacement of components.

All normal liquid release pathways to the environment are continuously monitored to ensure that the dose to the general public will be well within the allowable limits of 10 CFR 20 and 10 CFR 50, Appendix I.

Ultraviolet (UV) Total Organic Carbon Reduction System

Organically contaminated water produced by plant operation is drained into the liquid radwaste system for treatment. Total organic carbon (TOC) can be treated using UV radiation. Certain wavelength UV radiation has the capability to destroy TOC by breaking bonds and oxidizing the organic compounds. The process passes the waste stream past UV radiation emitting lamps. The effluent from the unit can then be demineralized to remove the products of the TOC breakdown.

To treat various liquid radwaste streams, a portable UV water treatment unit will be used as necessary to reduce organics from the liquid radwaste process waste streams.

B. GASEOUS RADWASTE SYSTEM

Design Objectives

The design objectives of the gaseous radwaste system are to process and control the release of gaseous radioactive effluents to the site environs so that the releases are a small fraction of the concentration limits as defined in 10 CFR 20, Appendix B, and are as low as reasonably achievable, as required by 10 CFR 50, Appendix I; to keep iodine releases within the total yearly release limit of Regulatory Guide 1.42;[12] and to operate within the emission rates established in the Offsite Dose Calculation Manual radiological effluent controls.

System Description

The largest single source of gaseous radwaste from the Fermi 2 plant is the offgas removed from the main condenser. For the treatment of this source of gaseous radwaste, the gaseous waste processing system, referred to as the offgas system, has been incorporated in the plant design.

Other sources of gaseous radwaste include releases from the turbine gland seal steam condenser and releases to the various plant ventilation systems from potential leakage of main steam and primary coolant. Although attempts are made to limit leakage to a minimum, small leaks at rates which make their detection difficult are expected.

C. SOLID RADWASTE SYSTEM

The Fermi 2 Solid Radwaste System is intended primarily to process and package radwaste for ultimate burial/disposal. It could be considered as three separate systems. The first is for handling dry waste (DAW), whereas the other two are for handling waste resulting from processing liquids. One of these is a vendor supplied system, located in the radwaste on-site storage facility (OSSF), which normally processes liquid radwaste by dewatering or solidification, etc. The second is the asphalt-extruder process system, located in the radwaste building. Each of these systems would produce end products which can be shipped and disposed of in full compliance with the appropriate state and federal regulations.

Note: This section describes the as-designed and as-installed design basis of the Radwaste Solidification System (asphalt extruder system). However, this system has never been operational. Pre-operational testing of this system was suspended in 1987 before testing was completed. This entire system, including all subsystems and components, remains fully in place, and has not been isolated by any plant modifications. It could conceivably become operational at some time in the future, if needed. Therefore, the original design-basis description, design data, figures, and tables for the solidification system are being retained in Section 11.5 and in other pertinent sections of this UFSAR as historical information, in the event that the system may be used at a later date. The system descriptions and design bases are all technically correct, although their flow paths are not operational at this time. Currently, full-time "solid radwaste" processing takes place in the On-site Storage Facility with a vendor-supplied system.

The installed Fermi 2 solid radwaste system is the radwaste volume reduction and solidification system, which was designed by the Werner-Pfleiderer Corporation; the volume reduction and solidification system is described in detail in a topical report (WPC-VRS-1) through Amendment II, approved for use as a reference by the NRC on April 12, 1978.

---

[12] Regulatory Guide 1.42 was withdrawn March 18, 1976, with the adoption of Appendix I to 10 CFR 50 and the development of a series of implementing guides.

The key difference between the design described in the referenced topical report and the Fermi 2 design is the feed concept. The topical report describes a slurry feed, whereas the Fermi 2 plant uses a centrifuge feed concept with a slurry feed as a backup.

Three subsystems described in the topical report are not included in the Fermi 2 scope of supply. First, the distillate skid has been replaced by a process that returns the water to other parts of the radwaste system for cleanup. Second, the lubrication oil skid was eliminated by using an extruder gear box design with integral lube oil circulation capability. Third, the overhead bridge crane listed in the topical report has been replaced with a monorail.

Design Objectives

The objectives of the solid radwaste system are to collect, process (solidify or dewater), and package liquid and wet solid wastes and slurries from the liquid radwaste system, the reactor water cleanup (RWCU) system, the fuel pool cooling and cleanup system, and the condensate demineralizer system. The solid radwaste system collects and processes the increased volumes of wastes and slurries that are produced during anticipated operational occurrences without affecting the operation or availability of the plant. It processes, packages, handles, and temporarily stores radioactive wastes and provides a means to transfer solidified or dewatered wastes to vehicles for transport ultimately to an offsite burial facility.

A subsystem also packages, stores, and prepares for transport compressible dry wastes generated during operation of the plant. These wastes include paper, rags, and other disposables that are normally processed conveniently by compaction.

The process equipment and disposable containers prevent the release of significant quantities of radioactive material, and keep the radiation exposure of plant personnel and the general public as low as reasonably achievable (ALARA).

The system is designed to

a. Collect and solidify or otherwise process radioactive wastes, which consist primarily of evaporator bottoms, filter backwash, tank sludge letdown, and spent resins

b. Provide for the transfer of decantate, resin sluice water, etc., to the liquid radwaste system for processing and eventual reuse or controlled discharge

c. Package, handle, and temporarily store processed, solidified, and compressed radioactive wastes generated as a result of normal operation of the plant, including those from anticipated operational occurrences.

d. Provide a means to transfer the packaged wastes to vehicles for transport ultimately to an offsite burial facility

e. Package radioactive wastes in a manner that will allow shipment and burial in accordance with all applicable federal and state regulations

f, Provide means for processing or the solidification of wet wastes that results in freestanding water in the final product less than that required for disposal

g. Provide means to transfer wet wastes to the vendor-supplied system in the OSSF

h. Compact dry waste in a container that is suitable for transportation and eventual burial

i. Protect plant personnel from radiation exposure and incorporate the basic ALARA principles through the use of automated systems, shielding, and remotely operated instrumentation and controls.

Fermi 2 is operated in accordance with its process control program (PCP), which is reviewed and approved by the NRC. The purpose of this PCP is to provide reasonable assurance of the complete solidification, encapsulation, or dewatering of processed wastes and the absence of free water in excess of required limits in the processed waste. For vendor-supplied processing services, a PCP approved by Edison and reported to the NC in accordance with the Technical Specifications will be utilized.

System and Equipment Description

The solid radwaste system collects, processes, and packages the liquid wastes, wet solid wastes, and slurries from the liquid radwaste system, the RWCU system, the fuel pool cooling and cleanup system, and the condensate demineralizer system. The solid waste package produced by the process must be suitable for transportation to an offsite burial facility. In the course of processing liquid inputs, the solid radwaste system must be able to separate solids from the incoming slurries, which maximizes the amount of liquid that can be returned to the liquid radwaste system for recycling to the plant.

The solid radwaste system will receive periodic inputs from a variety of plant sources. Since the operator should know in advance of major impending inputs of waste batches to the solid radwaste system, system operation can usually be planned before most inputs are received.

The inputs to the solid radwaste system consist of filter backwashes of several types, evaporator concentrates, and spent bead resin. By volume, most of this input is liquid. A major goal of the solid radwaste system is to allow solids in the liquid inputs to settle, leaving a relatively clear decantate, which is sent to the liquid radwaste system for processing. The remaining solids are pumped to an intermediate set of collection tanks from which the sludge (resin beads, powdered resin, and tank sludge) is pumped for final processing, either to the vendor system in the OSSF or to the asphalt solidification system. In the event of a centrifuge failure, the wet waste can be forwarded directly to the solidification process, where the liquid is drive from the waste, leaving only a dry, solid product. One exception to this process is the evaporator concentrates source, which is pumped directly to the solidification process without an intermediate solids settling step. The drains from the high-chloride laboratory are also fed directly to the extruder/evaporator via the chloride waste tank and the concentrates feed tank.

For the installed system, asphalt is used as the solidification binder. The asphalt and waste are heated and mixed in an extruder/evaporator that simultaneously removes the remaining moisture from the waste while producing a homogeneous product. When the asphalt/waste mixture cools, it forms a solid, homogeneous product that has no freestanding water. The asphalt storage tank is located at grade, on the north side of the radwaste building, opposite the floor drain filter. The radiation zone in this area is designed to be less than 1 mrem/hr and is therefore in compliance with Branch Technical Position (BTP) ETSB 11-3, which states that solidification agents should be stored in low-radiation areas that are less than 2.5 mrem/hr.

Dry Wastes

Typical values of the radionuclide content and volumes of dry solid waste for BWRs are provided in the table below.

Dry wastes (usually of low activity) can normally be handled by direct contact. These wastes are collected in bags or containers located in appropriate zones at certain locations within the plant, as determined by the volume of waste generated during plant operation and maintenance. The filled waste containers are sealed and transported for further processing.

Compressible, dry, low-activity wastes can be compacted into standard 55-gal drums by a hydraulic compactor. First, an empty drum is placed on the support plate at the front of the compactor and is moved into position under the ram by a hydraulic cylinder. Then a hinged work table is swung into position against the drum, clamping it in place and providing a seal for the air space above the drum that holds loose waste in place for compaction. Loose waste is deposited in the drum through an access door above the work table. Finally, the access door is closed and locked, and the loose waste is compacted.

Noncompressible wastes are normally packaged in strong, tight containers. Because of its low activity, this waste can be stored until enough is accumulated to permit its economical transport to an offsite burial ground for final disposal. During outages or other heavy trans-generating periods, or for packaging of large pieces of noncompactable materials, boxes may also be used to limit handling and ensure packaging efficiency.

Activated charcoal, HEPA filters, and other dry wastes are treated as radioactively contaminated solids. Those that normally do not require solidification processing are packaged and disposed of in accordance with applicable regulations.

Wet Wastes

Wet wastes consist of spent bead and powdered resins, filter sludge, and evaporator concentrates (when running). They normally result as by-products from liquid processing systems and contain liquid components that require immobilization or removal. By evaporating the liquid components and combining the residues with the asphalt binding agent when the asphalt-extruder system is used, a homogeneous solid matrix of reduced volume and free of water is developed prior to offsite shipment. When the vendor-supplied system is used, wastes can be dewatered or solidified.

Spent cartridge-filter elements may be packaged in a shielded receptacle containing a suitable absorber. If necessary, they will be stored and shipped in the same manner as other radwaste in accordance with applicable regulations.

Irradiated Reactor Components

Because of its high activation and contamination levels, used reactor equipment is normally stored in the spent-fuel storage pool to allow sufficient radioactive decay before its removal to in-plant or offsite storage and its final disposal in shielded containers or casks.

Equipment Description

The selection of the solid radwaste system process components was based on the primary process requirement to dewater solid-laden waste inputs. The process of removing the moisture from the solid waste streams provides a volume reduction of the incoming feed, thus reducing the ultimate amount of waste to be disposed of. The liquid generated by the dewatering processes is returned to the liquid radwaste system for further processing.

Solid wastes are collected in several different ways. Liquid wastes with a low solid content are received in the condensate phase separators, where they are allowed to settle; then the clarified decantate is pumped to the waste clarifier tank. Overflow from the clarifier tank is directed into the waste surge tank and finally into the liquid radwaste system (waste collection subsystem). The sludges from all three tanks are normally fed to the centrifuge feed tank. Other wastes with higher solids content are added to this basic line at intermediate points. The sludge from the RWCU phase separator is fed directly to the centrifuge feed tank. The spent-resin tank feeds either the centrifuge feed tank or the spent-resin slurry feed tank, which feeds directly into the extruder/evaporator. The evaporator bottoms and the chloride wastes are fed to the concentrate feed tank, where a caustic is added for neutralization, before they are pumped into the extruder/evaporator.

The two condensate phase separators perform a primary clarification of the waste sources that contain high suspended solids (excluding evaporator bottoms and exhausted demineralizer bead resins). After collection, the wastes are allowed to settle, clarified liquid is decanted off the top, and sludge is drawn off the bottom.

The waste clarifier tank performs a secondary clarification of condensate phase separator decantate and other wastes with low concentrations of suspended solids. The influent wastes flow through the waste clarifier tank, where the solids settle to the bottom and the clarified liquid overflows into the waste surge tank. From the waste surge tank, the clarified liquid is forwarded to the waste collector subsystem for processing. Sludge collected in the bottom of the clarifier tank is pumped out periodically to the centrifuge feed tank. Any solids that might collect in the waste surge tank can be blown down to the condensate phase separators. The waste clarifier tank also provides a source of relatively clear water, which is used for diluting the contents of the centrifuge feed tank and transporting resins from the spent-resin tank.

The spent-resin tank receives bead-type ion-exchange resins and demineralizer flushes that are produced by dumping the exhausted floor drain and waste collector demineralizer beds. The spent resins and flush water are forwarded to the centrifuge feed tank.

To summarize, the centrifuge feed tank receives concentrated sludges from the condensate phase separators, waste clarifier tank, cleanup phase separators, and spent-resin tank. The feed-tank contents are mixed by recirculation and mechanical agitation to give a consistent concentration; a side stream is taken off the recirculation loop for ultimate processing, either to the vendor equipment in the OSSF or to the asphalt-extruder system via the centrifuge. When the extruder system is used, centrifuged solids and high dissolved-solids wastes from the concentrates feed tank are sent to the unit, where they are drifted and mixed with asphalt. The asphalt/solid mixture is emptied into drums that are capped and sent to storage for eventual offsite disposal. Distillate from the evaporation process is returned to the waste clarifier tank. The sludge normally routed to the centrifuge for dewatering can also be routed directly to the extruder/evaporator when the centrifuge is not available. Similarly, spent resin can be routed to the alternative spent-resin slurry feed tank for forwarding to the extruder/evaporator when the centrifuge is not available.

Extruder/Evaporator Volume Reduction and Solidification System

The extruder/evaporator volume reduction and solidification system (VRS) is designed to perform the following functions:

a. Accepts waste inputs from the liquid radwaste system evaporator and chloride waste tank via the concentrates feed tank as well as waste in slurry form from the centrifuge feed tank

b. Accepts dewatered solid waste inputs from the centrifuge or slurry inputs (approximately 50 percent by weight) from the slurry feed tank

c. Removes moisture from waste feed while homogeneously mixing the waste with asphalt

d. Discharges the asphalt/waste mixture into 55-gal drums where the waste product cools to form a solid mass with no freestanding water

e. Crimps the 55-gal drums to form suitable containers for offsite disposal

f. Returns the cooled distillate resulting from the evaporative process to the waste clarifier tank.

The nominal rated capacity (120 liters per hr) of the VRS-T 120 is the evaporative liquid. A weight percent of solid to liquid is present in each incoming stream so that the amount of incoming water does not exceed the capacity of the extruder/evaporator. The mass flow rate into the centrifuge is controlled so that the moisture input to the extruder/evaporator, in the form of chemical-bound and surface-bound water, does not exceed its evaporative capacity.

The VRS is designed to process the radioactive wastes from the solid radwaste system collection tanks described above. The principal types and quantities of wastes processed have been estimated in the design as follows:

a. Concentrates Feed Tank

Volume/batch	800 gal
Annual volume	34,679 gal

b. Bead Resin

Volume/batch, dewatered	49 ft^3
Resin type	Rohm & Haas IRN-150 or equivalent
Annual volume	6500 ft^3 (50,000 gal)

c. Powdered Resin

1. Condensate Phase Separators

Batch weight, dewatered	2250 lb
Annual quantity, dewatered	64,800-137,000 lb (10,300-21,800 gal)

2. Reactor Water Cleanup Phase Separators

Batch weight, dewatered	580 lb
Annual quantity, dewatered	3480 lb (575 gal)

The volume reduction and solidification system includes the following subsystems:

a. Centrifuge feed system
b. Concentrate feed system
c. Spent-resin slurry feed system
d. Asphalt feed system
e. Auxiliary steam system
f. Extruder/evaporator and utility manifold
g. Steam-dome boilout system
h. Cooling water booster pumps
i. Fill station/drum-handling system
j. pH adjustment system.

Fill Station and Drum-Handling System

a. Positions a drum under the extruder for filling

b. Provides ventilation of the drum being filled

c. Provides visual monitoring of the drum-filling process

d. Provides a remote indication of the drum level

e. Provides temporary storage for cooling on the turntable

f. Provides an automatic/manual indexing operation

g. Provides a drum-capping and drum-seaming operation

h. Provides for measuring drum radiation level at the capper/seamer

i. Provides drum handling, which consists of a monorail, a drum grab, conveyors, and a capper/seamer.

The fill station subsystem collects the final product from the extruder/evaporator. The fill station contains a vent hood, filter train, and exhauster, which provide ventilation of the fill area to prevent loose surface contamination of drums and the buildup of vapors. A drip-pan mechanism is provided for product collection during drum-indexing operations. The pan with drippings is put in the next drum available after indexing. The drum-handling system is designed to transport drums to and from the six-drum turntable via the monorail, hoist, and rum grab. The drums are filled on the turntable after being indexed, either manually or automatically. Filled drums are remotely transported via monorail and hoist to the capping station. They are capped, seamed closed, and put on the transfer cart.

The drum-handling system provides a means by which 55-gal drums filled with the solidified radwaste can be remotely moved, transported, and stored. It consists of a transfer cart, an accumulation conveyor, and a 10-ton remotely operated bridge crane equipped with a drum grab for transport of drums to on-site storage. Drums are retrieved from on-site storage by means of the same bridge crane. They are discharged to a truck dock designed to accommodate offsite shipments to a burial repository.

Except for the drum-transfer cart, these actions occur in the on-site storage facility, a separate structure adjacent to the radwaste building.

One method of movement of drums is as follows: Filled and seamed drums are moved from the drum capper-seamer area, by means of the transfer cart, to the on-site storage facility. There they are transferred to the accumulation conveyor to await transport off-site or to their storage location. A swipe station is provided in the on-site storage facility to permit checking of drums for surface contamination prior to storage or shipment offsite. Closed-circuit television (CCTV) cameras throughout the system permit surveillance of the drum's movement.

Drums can also be stored on the solid-radwaste storage conveyors in the radwaste building (first floor). this subsystem shares the drum-transfer cart, swipe station, and truck dock used for the on-site storage facility. The storage system consists of the transfer cart, 13 reciprocating gravity storage conveyors, 13 drum escapement devices, and a chain-driven live roller drum-exit conveyor. All components of this system are remotely operated, and visual surveillance of the total system is provided by CCTV cameras, periscopes, and viewing ports.

Drums are discharged from the transfer cart onto any one of the 13 reciprocating gravity storage conveyors. Drums are discharged from this area by an escapement device and are transported via the drum-exit conveyor to the swipe station. The reciprocating gravity storage conveyors can store approximately 380 drums.

<u>pH Adjustment System</u>

The pH adjustment system consists of a caustic holding tank, pumps, and a distribution system. It is used to adjust the pH in the three slurry feed tanks to protect the extruder/evaporator. The caustic is fed from the caustic tank and distributed through the caustic addition pumps to one of the three slurry tanks:

a. The centrifuge feed tank
b. The spent-resin slurry feed tank
c. The concentrates feed tank.

When the pH in the selected tank is within the allowable range, the operator manually shuts down the caustic addition pump.

The system also provides for the injection of caustic for neutralizing the contents of the chemical waste tank.

Packaging and Shipment

The solid waste system product will be packaged and shipped in accordance with current federal regulations. The majority of normal radwaste will be staged in the on-site storage facility for shipment. Waste quantities, activities, and economics will dictate shipment frequency.

Vendor-Supplied Solidification or Dewatering System

The Fermi 2 solid radwaste system has been set up and hard-piped so that either a full-time (mobile) vendor system can be used or the asphalt system could be used.

The portable solid waste management system is supplied and operated by the vendor in accordance with the requirements and description in their topical report, which has been submitted to the NRC. The types and quantities of waste to be processed are the same as for the Fermi solidification system. System operation will be closely monitored by Edison personnel. The vendor will utilize a process control program (PCP), which is reviewed and approved by Edison in accordance with the Technical Specifications. Conformance to 10 CFR 61 criteria is discussed in the vendor-supplied documentation , which is submitted to the NRC, Fermi 2 or contractor operating procedures are used for operating this system as interfaced with the Fermi 2 solid radwaste system.

The portable system is located in the pallet loading and/or laydown areas immediately adjacent to the truck bay area of the on-site storage facility, with the exception of large bulk cement and chemical containers which, if used, may be located outside the truck bay door. These areas of the on-site storage facility were specifically designed and constructed to contain and handle mobile process systems. Concrete floors and walls of this region are coated, and all drains are routed back to the liquid radwaste system. The remote-operated overhead crane is available to move equipment onto or from trucks located in the truck bay. The basic design of these areas and the methods of system operation have incorporated features to maintain operator exposures ALARA. Permanent piping installed in the shielded on-site storage facility pipe tunnel transports the radioactive process fluid directly to the vendor's equipment.

In general, liquid from the centrifuge feed tank is transported directly to the vendor equipment, and clarified liquid is returned to the waste clarifier tank. The waste is normally pumped to a disposable liner or high-integrity container (HIC).

If solidification of waste is performed, pretreatment of the waste with chemical additives may be conducted in accordance with values derived from a PCP. Solidification agents are then added and the waste is allowed to cure to complete the solidification process.

If dewatering of the waste is performed, the waste is transferred into a steel liner or HIC containing an internal underdrain assembly. Vacuum is applied to the underdrain system. Liquid from the underdrain system is sent back to the liquid radwaste system by a dewatering pump while the solids are trapped in the container. Some vendors provide additional accelerated dewatering capability. This accelerated capability is achieved by recirculating air at high velocity through a liner or HIC. Procedures ensure no drainable liquid at the time of shipment and <1 percent drainable liquid in HICs or <0.5 percent drainable liquid in steel liners upon receipt at the burial site.

The liners or HICs are suitable for transportation and burial at an approved burial facility. Additionally, the liners and HICs are compatible with numerous approved shipping casks if the liner or HIC requires shipment in a cask.

D. ON-SITE STORAGE FACILITY

Introduction

The on-site storage facility is essentially an above-grade structure for holding low-level radioactive waste. It provides interim storage capacity for an amount of waste estimated to be generated in 5 years of plant operation. This surge capacity is primarily intended to be used to allow Fermi 2 to continue operating during a period when no offsite disposal facilities are available. Under normal conditions, when offsite disposal is available, a portion of the storage facility will be used as a staging area for waste. The on-site storage facility also includes space for a dry active waste compactor, offices, a control room, and rooms for housing the radwaste solidification system's asphalt storage tank and pumps. Provision is also made to allow processing of radwaste by transportable vendor-supplied equipment inside the facility.

Design Objectives

The on-site storage facility provides a protective barrier around the stored waste to

a. Protect the waste containers from the effects of the environment

b. Prevent an uncontrolled release of the waste to the environment

c. Provide shielding from the radiation emitted by the waste.

The waste will be retrievable from the facility. Waste will not be stored permanently in the facility. Handling of the waste within the facility can normally be done remotely with a crane or, when radiation levels allow, with a hand truck or a forklift vehicle.

The waste containers will be stored inside the structure, which protects them from the external environment. The storage facility has full-length trench drains in each storage cell to prevent collection of water on the facility floor.

All potential pathways for the release of radioactivity to the environment are controlled and monitored in accordance with 10 CFR 50, Appendix A, Criteria 60-64. In particular, all potentially contaminated rains within the facility are collected and routed to the liquid radwaste system. All ventilation exhaust from the on-site storage facility is filtered and monitored for radioactivity.

Description of Waste Stored

Normally, the radioactive wastes to be stored in this facility are of three general types: dry active wastes, processed wastes, and miscellaneous unprocessed wastes. Storage containers for processed waste could be either liners, high-integrity containers, or drums. High integrity containers will be used for processed waste which is potentially corrosive. Containers for dry active wastes could be drums, low specific activity boxes, or other appropriate containers. Waste with the potential for gas generation is stored in vented containers, or the container shall be vented at least every 5 years.

The dry wastes, which are generally of low radioactivity, can normally be handled by direct contact. These wastes normally are collected in containers or bags located in various zones around the plant. The filled containers are closed and then transferred to the on-site storage facility. These wastes are of two types: compressible and noncompressible. The compressible wastes are normally processed and packaged. The noncompressible wastes are manually packaged into containers meeting transportation criteria and stored until shipment.

Design Safety Features

To reduce the possible exposure of personnel during maintenance, the following concepts have been incorporated into the design of the on-site storage facility:

a. Lighting will be provided via the bridge cane. No lights have to be replaced over the high level radwaste storage cells

b. The swipe-sample and drum-decontamination station has been provided with adequate shielding to minimize exposure during these operations

c. Epoxy coating has been provided on all floors and walls where potential contamination could occur

d. Access to the bridge crane and its cables will normally be over the truck bay to reduce exposure to maintenance personnel

e. Normal operations involving the storage containers and bridge crane can be performed remotely.

Onsite Storage Facility

Location

The on-site storage facility is located at the northeast corner of the existing radwaste building. The facility's control room, compactor area, offices, and asphalt tank rooms are located adjacent to the north wall of the radwaste building and are attached to the on-site storage facility. The entire complex is located within the site-protected area.

Design Features

Structural and Architectural

All surfaces in the on-site storage facility are sloped to drainage ditches or drains that are connected with the liquid radwaste collection systems. Rainwater is prevented from entering the facility by a rise in the grade at the entrance of the facility and a drainage ditch that connects to the on-site sewer system. Drains from the heating, ventilating, and air conditioning (HVAC) system are connected to the radwaste collection system.

The on-site storage facility is a non-safety-related structure and is designed and constructed in accordance with the following codes and standards:

a. ACI-318-77: American Concrete Institute, Building Code Requirements for Reinforced Concrete

b. AISC-1978: American Institute of Steel Construction, Specification for the Design Fabrication and Erection of Structural Steel for Buildings

c. ANSI-58.1-72: American National Standards Institute, Building Code Requirements for Minimum Design Loads in Buildings and Other Structures. The wind loading will be based on the 50-year mean recurrence interval

d. UBC-79: Uniform Building Code. The main plant requirements for the operating-basis and safe-shutdown earthquakes will not be considered, in accordance with NRC Generic Letter 81-38. The on-site storage facility is designed to comply with UBC-79 requirements for Seismic Zone 1

e. OSHA: Occupational Safety and Health Administration requirements

f. ACI-531-79: American Concrete Institute, Building Code Requirements for Concrete Masonry Structures

g. NRC Regulatory Guide 1.143: Pipes, joints, and fittings of the piping from the main radwaste system to the piping connection for the portable solidification system.

The on-site storage facility is constructed of the following noncombustible materials:

a. Exterior - reinforced-concrete and reinforced-concrete block walls, reinforced-concrete roof, insulated metal siding, and hollow metal doors

b. Interior - reinforced-concrete walls.

The rooms housing the asphalt storage tank and pumps are constructed of concrete block walls and have a connecting, approved fire-rated door. Both room are accessible only from an outside entrance. A high wall with a door sill that can contain the full contents of a tank rupture is located in the asphalt storage tank room. There are no drains in this room, nor are there any in the adjacent pump room.

To ease any potential problems with decontamination, all floors in the facility are finished with two layers of epoxy coating. The walls are coated to a level of 2 ft above the floor, with the exception of the truck-bay area and the decontamination station cubicle, where the coating extends to the top of the interior wall.

Flood Protection

The on-site storage facility is located above the maximum flood elevation of 586.9 ft. The drum storage area is at Elevation 587.0 ft. This is 4 ft above the plant grade elevation of 583.0 ft. Therefore, flooding is not considered a design-basis event.

Tornado Protection

The minimum thickness of concrete walls below Elevation 624 ft is 54 in.; above Elevation 624 ft, it is 28 in. The minimum thickness of the concrete slab for the roof is 4 in. It is unlikely that a tornado would damage a building with this structural integrity to the extent that the building's contents would be scattered. Therefore, a tornado is not considered a design-basis event.

Provisions for Liquid Drainage

The on-site storage facility is provided with an extensive system of drains and trenches. All surfaces in the facility are sloped so that any spillage is directed toward one or more of the drains. Because of this network, permanent curbs are not provided.

All drains in potentially contaminated area of the on-site storage facility are routed directly to the floor drain collector subsystem of the liquid radwaste system. These include drains in the drum-storage areas, the truck-bay area, the drum-decontamination station, the HVAC equipment room, and the drum-compactor area. These drains are adequately sized for all normally expected influents and will also drain water from the fire-suppression system.

Compaction

To decrease the volume of solid waste, the on-site storage facility contains a high-efficiency, in-drum, ram-head compactor system with a filtration and ventilation system.

The ventilation system controls any contaminated particles that may be released while the packaging equipment is being operated. The compacting press has an air exhaust system, consisting of a hood, a prefilter and absolute filter, and an exhaust fan.

This system is so arranged that when the ram descends to compress waste material, the air exhaust system is in position to filter the air from the drum as the material is compressed.

When the compactor is used, the compressible trash, which is made up of low-activity material, including glass, paper, rags, mop heads, booties, gloves, and towels, is normally transported to the compactor room in plastic bags. The trash is then placed in the drums and compacted. When a drum is filled, the top is fastened onto the drum, and a forklift truck or, when radiation levels allow, a hand truck is used to transport the drum from the compactor room to the drum-staging or drum-storage areas.

Temporary Processing

Permanent piping is routed from the radwaste system to the on-site storage facility to allow vendor processing and/or solidification of wet waste in the truck-bay area and adjoining rooms.

All pipes run in a shielded pipe tunnel beneath the storage facility and conform to ANSI B31.1. An access hatch to the pipe tunnel beneath the storage facility is located in the truck bay area. The radwaste pipelines terminate in the truck bay. A blind flange is at the termination of each line. Each pipeline is capable of being flushed as necessary with condensate. Water decanted from processed waste in the truck bay will be returned through the pipelines to the liquid radwaste system in the radwaste building. When vendor processing is utilized, the wet waste will be pumped through the pipelines to commercial process equipment provided by the vendor. The permanent radwaste piping will be connected at the flange fittings to the equipment provided by the vendor.

Operations

The asphalt solidification system in the radwaste building dewaters and solidifies the radwaste in 55-gal drums; these drums can be moved from the radwaste building to the on-site storage facility by either of the two methods described earlier.

Drums of compacted waste are normally brought into the facility by a forklift truck or, when radiation levels allow, by a hand truck. The crane can then lift each drum and perform essentially the same functions as with the drums of solidified waste. Alternatively, the forklift or and truck can be used to place the drums of compacted waste into storage.

The facility is designed for one-on-one stacking of 55-gal drums, up to eight layers in height, with steel grating between each layer. Tests performed for Sargent & Lundy engineers indicate that the maximum compressive load that an 18-gage 55-gal DOT-17H drum on the bottom layer (with seven layers above) will be subjected to a maximum compressive load of 3,395 lbs, which is only 57 percent of the failure load. Drum manufacturers' data indicate that the maximum compressive load a 55-gal DOT-17E drum can withstand before failure is 10,000 lbs. During storage, a 17E drum on the bottom layer will be subjected to a maximum compressive load of 4,970 lbs. Thus, the maximum load that a 17E drum on the bottom layer will be subjected to is only 50 percent of the failure load. This provides confidence that eight-high drum stacking is safe and justifiable for 55-gal drums. The dry active waste can be stored in 55-gal drums having the same dimensional, physical, and strength characteristics as Department of Transportation (DOT) type 17H drums. The solidified waste will be stored in drums having the same dimensional, physical, and strength characteristics as DOT type 17E drums. In such a case, eight-drum stacking is possible. When other storage containers (liners, HICs, non-standard drums, etc.) are utilized, eight-high stacking would not be used.

The storage facility is separated into cubicles by inner walls. This allows the potential segregation of waste containers by radioactivity level and/or waste type. Compacted dry active waste can be stored separately from processed waste. Also, sample drums from each batch of solidified radwaste resins can be stored in the test and sample area of the on-site storage facility.

A record board is located in the control room of the on-site storage facility, which can be used to record the position of all containers stored in the facility. The board consists of a plan view of the storage areas, with container setdown positions identified by alphanumeric designations that correspond to the bridge crane coordinate grid system. The operator can place a tag on the board for each container. The tag can contain such information as container number, weight, radiation level, and date of storage, etc.

2.6.2.9 Palisades

A. LIQUID RADIOACTIVE WASTE SYSTEM - DESIGN BASES

Design Objective

The Liquid Radioactive Waste System is designed to collect, store, process, monitor, and dispose of all liquid radioactive wastes from the Palisades Plant. The principal design criterion is to ensure that the general public is protected from exposure to radioactive waste products in accordance with Title 10, Code of Federal Regulations, Part 50 (10 CFR 50), Appendix I. The system was modified during 1971-1973 following voluntary agreement between Consumers Power Company and outside intervenors to reduce liquid discharges to Lake Michigan to essentially "Near-Zero" as achievable by use of modern processing equipment which permits recycling of most liquids. This modification consisted of the addition of clean waste evaporators and auxiliary equipment which were integrated into the Liquid Radioactive Waste System to provide clean waste recycle features reducing radwaste effluents.

SYSTEM DESCRIPTION

The Liquid Radioactive Waste System is divided into three sections: (a) the clean waste section which processes high-activity, high-purity (low solids) liquid waste, (b) the dirty waste section which processes low-activity, low-purity (high solids) liquid waste and (c) the laundry waste section.

Clean Waste Section

In the clean waste section of the Liquid Radioactive Waste System, wastes are collected, monitored, and processed by a combination of holdup (thereby permitting natural decay), filtration and ion exchange treatment (removal of insoluble particulates and soluble ions), evaporation (volume reduction), and under normal conditions, are stored for eventual recycle back to the Primary Coolant System. Quantities of clean waste are obtained from the Chemical and Volume Control System's bleed letdown (primary coolant), and are generated due to Plant start-ups and shutdowns which require that primary coolant boron concentrations be varied to maintain the necessary shutdown margins.

Liquid waste from the Chemical and Volume Control System first passes through an ion exchanger and purification filter before entering the clean waste section. In the clean waste section, this stream passes through the vacuum degasifier and is then discharged into one of the clean waste receiver tanks. The vacuum degasifier removes hydrogen and fission product gases and discharges them to the waste gas surge tank located in the Gaseous Radioactive Waste System.

The primary system drain tank collects liquid waste from sources within the containment building. The primary loop drains provide the major source of liquid to the drain tank. Liquid waste from the primary system drain tank is also passed through the vacuum degasifier before entry into one of the clean waste receiver tanks.

The equipment drain tank collects liquid waste from outside the containment building. Liquid waste from the equipment drain tank is discharged to the clean waste receiver tanks through a filter.

The radiochemistry lab drain tank collects the liquid waste generated while sampling the primary coolant for chemical and radiochemical analysis. Liquid waste from the radiochemistry lab drain tank is discharged to the Solid Waste Management System for solidification or can be sent to the dirty radwaste evaporator for volume reduction.

Four 50,000-gallon clean waste receiver tanks located inside the containment building provide temporary storage for collected liquid waste to allow for natural decay and to permit sampling of liquid waste activity. Liquid waste from the receiver tanks is discharged through the clean waste filter to remove insoluble particulates and through the radwaste demineralizers to remove soluble ions.

Under normal conditions, the effluent from the clean waste demineralizers passes to the clean waste holdup tank or to a clean waste receiver tank, and then to the clean radwaste evaporator. The evaporator has the capability to process radioactive waste either continuously or in the batch mode. The clean radwaste evaporator concentrates boric acid and radioactive isotopes, except for gases and tritium. The evaporator concentrates are discharged to the clean waste concentrate tank, while its relatively pure distillate is discharged to the clean waste distillate tank.

The boric acid obtained from the clean radwaste evaporator is then pumped into the recycled boric acid storage tank where it is available to the Chemical and Volume Control System for reuse in the Primary Coolant System. However, if the boric acid cannot meet the quality requirements specified in the Plant's Technical Specifications, it is sent to the Solid Waste Management System where it is prepared for packaging and disposal.

The distillate from the radwaste evaporator is normally processed through a polishing demineralizer to further reduce boron and radioactivity concentrations, and is then sent to the primary system makeup storage tank where it is stored until used by the Chemical and Volume Control System in making up the primary coolant.

If the distillate volumes become excessive under abnormal operating conditions or cannot meet the quality requirements specified in the Plant's Technical Specifications, provisions are available to send the distillate from the evaporator to the treated waste monitor tanks for holdup and sampling to determine the disposition of this liquid. Process routes available from these tanks include reprocessing through the clean radwaste evaporator, return to the clean waste receiver tanks for further decay and later processing, or to be routed to the circulating water discharge for dilution and release to the environment after reduction to levels that are as low as reasonably achievable.

Dirty Waste Section

In the dirty waste section of the Liquid Radioactive Waste System, wastes are collected, monitored and processed by a combination of filtration, evaporation and demineralization. The dirty waste drain tank collects liquid waste from the sources listed in Table 11-7.

Liquid from the dirty waste drain tank is processed through the miscellaneous waste filters while en route to the miscellaneous waste holdup tanks for temporary storage. Effluent from these tanks is fed to the dirty radwaste evaporator which is identical to that in the clean waste system. The distillate from the evaporator is sent to the miscellaneous waste distillate tank and then through either one or two demineralizers to the utility water storage tank for reuse in the Plant. If the distillate volumes become excessive under abnormal operating conditions or cannot meet the quality requirements specified in the Plant's Technical Specifications, provisions are available to reprocess evaporator distillate. Under extreme situations, discharge could be made to the discharge basin within limitations of the Plant's Technical Specifications.

The boric acid concentrate obtained from the dirty radwaste evaporator is sent to the evaporator concentrate tank. The concentrates are sent to the Solid Waste Management System for solidification and disposal.

Laundry Waste Section

All liquid effluent obtained from the on-site laundering of anticontamination clothing and the water from the face-mask decontamination washing station is processed through a media filter and basket strainer, both connected in series, before being temporarily collected in the laundry drain tank. The tank's contents are then sampled to determine the disposition routing for this waste stream.

Normal system lineup permits transport of this waste stream from this storage rank through three series connected filters having successive ratings of 50, 25 and 5 microns before being deposited into filtered waste monitor tanks. The latter filters were installed by a field change in 1977. These filters minimize clogging or fouling problems in the dirty waste section.

Alternate system lineup is available to transport this waste stream directly to the Plant's discharge mixing basin following filtration by the three series connected filters, and monitoring to assure that the discharged effluent activity is below permitted activity levels. However, discharge to the mixing basin is usually made from the filtered waste monitor tanks rather than by the alternate direct-discharge lineup.

Additionally, the laundry waste section's volumes have been greatly reduced by installation of an independent dry cleaning machine in early 1980 which utilizes recyclable solvents for laundering rather than generating water-based soap and detergent wastes which formerly constituted most of this section's volume throughput.

Both dry cleaning and wet wash machines were removed from service in 1989. All laundry is now processed offsite by a vendor. The drain and filter units are still in place. Small amounts of detergent wastes are dumped into the drain system and are drained into the normal dirty waste system instead of discharging directly.

B. GASEOUS RADIOACTIVE WASTE SYSTEM

DESIGN BASIS

The design basis for the Gaseous Radioactive Waste System is to efficiently store gaseous isotopes for a time period which will permit sufficient radioactive decay prior to their discharge to the environment within Technical Specification limits.

SYSTEM DESCRIPTION

The Gaseous Radioactive Waste System is divided into two sections: (a) the gas collection header which collects low-activity gases from liquids which have been previously degassed and/or vented in other waste handling steps, and (b) the gas processing section which collects gases from potentially high-activity sources.

<u>Gas Collection Header</u>

Gases which may contain potentially radioactive gases are passed through the gas collection header where they are discharged through a high-efficiency filter to the suction side of the main vent exhaust fans. The gases are diluted by ventilation exhaust air and are discharged through the ventilation stack to the atmosphere. The primary sources of low activity gaseous waste include the atmospheric vents of the liquid radwaste drain, collection and monitoring tanks, and containment building via "D" clean waste receiver tank (RUD-1018 removed).

<u>Waste Gas Processing System</u>

The waste gas processing system collects all potentially high-activity gaseous waste. The gas surge tank collects and absorbs surges from the demineralizer vents, shield and cooling surge tank vent, quench tank vent, primary system drain tank vent, volume control tank vent, vacuum degasifier vent (which takes input from either of two degasifier pumps) and evaporator vents. The waste gas surge tank discharges to one of three compressors which compress the gas for storage and decay in one or more of six waste decay tanks. If activities greater than 1×10^{-5} $\mu Ci/cm^3$ have not been detected, the waste gas surge tank can be discharged through a high-efficiency filter directly to the ventilation stack.

If the surge tank is discharging directly to the ventilation stack, a high-radiation condition (as identified by a continuously operating monitoring system taking samples from the discharge line) will automatically close the discharge valve which is upstream of the stack. On simultaneous occurrence of this high-radiation signal and high surge tank pressure, a waste gas compressor starts automatically and, taking suction from the surge tank, discharges to the decay tanks.

Three of the six waste gas decay tanks have a volume of 100 cubic feet each and are designed for 120 psig. The remaining three decay tanks (added during the 197-1973 auxiliary building addition) have a volume of 225 cubic feet each and are also designed for 120 psig. The total Primary Coolant System gas inventory and the gas inventory of the volume control tank can be stored in two of the smaller tanks if required for a cold, degassed Plant shutdown.

C. SOLID WASTE MANAGEMENT SYSTEM

DESIGN BASIS

The design basis for the Solid Waste Management System incorporates the applicable regulatory requirements, including the following:

Title 10, Part 20 (10 CFR 20), "Standards for Protection Against Radiation"

Title 10, Part 50 (10 CFR 50), "Domestic Licensing of Production and Utilization Facilities"

Title 10, Part 50, Appendix I (10 CFR 50, Appendix I), "Numerical Guides for Design Objectives and Limiting Conditions for Operation Guides To Meet the Criterion as Low as is reasonably Achievable for Radioactive Material in Light Water-Cooled Nuclear Power Reactor Effluents"

Title 10, Part 70 (10 CFR 70), "Domestic Licensing of Special Nuclear Material"

Title 10, Part 71 (10 CFR 71), "Packaging of Radioactive Material for Transport and Transportation of Radioactive Material Under Certain Conditions"

Title 49, Parts 170 and 171 (49 CFR 170 and 171), "Department of Transportation (DOT) Hazardous Materials Regulations"

NRC Information Notice No. 90-09, "Extended Interim Storage of Low Level Radioactive Waste by Fuel Cycle and Materials Licensees" (2/90)

NRC Generic Letter 81-38, "Storage of Low Level Radioactive Wastes at Power Reactor Sites" (11/81)

NRC Generic Letter 85-14, "Commercial Storage at Power Reactor Sites of Low Level Radioactive Waste Not Generated by the Utility" (8/85)

IE Circular No. 80-18, "10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems" (8/80)

Design and construction codes used in this system are generally identical with those depicted in Subsection 11.2.1.3 for Quality Group D system components and piping. In addition, the asphalt volume reduction (VRS) system processing equipment is located in a CP Co Design Class 1 building. On site buildings, other than the Auxiliary and Service buildings used to process and store radioactive waste are engineered structures, but are not seismically qualified.

Spent nuclear fuel is not covered by this section.

SYSTEM DESCRIPTION

The Solid Waste Management System is designed to collect, process, package and store for future offsite disposal low-level liquid wastes (consisting of evaporator concentrates), spent ion-exchange resins and assorted solid wastes according to type of waste and levels of radiation activity present.

<u>Original System</u>

Until the auxiliary building addition was added to the auxiliary building in 1972-1973, the original system was designed to process and package only dewatered spent ion-exchange resins which were sluiced into the 400-cubic-foot spent resin storage tank. Liquid wastes were discharged to Lake Michigan via the Plant's discharge mixing basin, and miscellaneous solid wastes were shipped offsite in boxes or drums depending on whether or not the solid wastes could be compacted into 55-gallon drums. Dewatered spent resin and expended filter cartridges were shipped from the Plant site in metal drums until 1973.

1972-1973 Modification

The quantities of wastes processed by the system were increased when modifications to the liquid and solid waste systems occurred during the 1972-1973 service building addition. These changes were brought about by legal commitments to change the Plant to a "near-zero" release Plant. These were the addition of ion-exchange resins obtained from the radwaste polishing demineralizer and the liquid concentrates (or "Bottoms") obtained as a by-product from the clean and dirty radwaste evaporators. However, concentrates from the clean radwaste evaporator normally do not contribute to the waste stream, whereas concentrates from the dirty radwaste evaporator are always processed by the solid waste management system. Also, a second spent resin storage tank having a capacity of 200 cubic feet was installed to provide holdup time which would permit natural decay prior to the packaging operation.

After 1973 and until late 1980, processing and packaging of evaporator concentrates was accomplished by use of a solidification system designed by Protective Packaging, Inc (PPI). This system metered evaporator concentrates with a precise amount of liquid urea-formaldehyde polymer solution (such as Cyanaloc-62 (American Cyanamid) or equivalent) into disposable liners of approximately 50 cubic-foot capacity.

The PPI urea-formaldehyde-type solidification system was used extensively until it was dismantled in late 1980 to facilitate installation of another type of solidification system. The new solidification system utilizes molten asphalt as the immobilizing constituent to be mixed with the waste concentrates or spent ion-exchange resin. The new system was installed in the same packaging room formerly used, but extends eastwards into a series of engineered rooms constructed above the former outdoor patio-roof area of the service building addition at elevation 625 feet 0 inch.

Interim Solid Waste System

In the interim period before start-up of the new solidification system, spent resins and filters were shipped offsite in dewatered state in approved high integrity containers manufactured from ultra-high molecular weight polyethylene. Liquid concentrates were physically transported in shielded 50-cubic-foot liners by vehicles to a temporary packaging area in north end of the feed water purity building. Processing and solidification of the concentrates were accomplished by commercial waste contractors utilizing a proprietary formula cement grout as the immobilizing constituent. Filter cartridges continued to be packaged damp dry as previously described. In 1983, the 55-gallon drum dry waste compactor was replaced with a box compactor designed to compress miscellaneous dry solids into 96-cubic-foot steel boxes.

Volume Reduction and Solidification System

The Werner & Pfleiderer volume reduction and solidification (VRS) system installed in 1983 utilizes one VRS-T120 extruder/evaporator to process the concentrates from the boric acid and liquid waste evaporators and the bead from ion-exchange resin. The system also has connections for processing powdered ion-exchange resin from the feedwater purity building if these materials become a source of radioactive waste.

The VRS system is a one-step process for reducing the volume of radwaste while incorporating the radwaste into a solidified asphalt matrix. Liquid radwastes or resin slurries and the asphalt binder are metered to a steam-heated twin-screw extruder/evaporator. As the radwaste moves through the extruder, the water is evaporated from the waste while the waste solids are simultaneously reduced to micron-sized particles and homogeneously dispersed in the asphalt. The asphalt and waste mixture is discharged from the extruder to standard waste shipping containers and the product solidifies upon cooling. The system does not require the addition of chemical agents to promote solidification and no free water is present in the final product.

Asphalt Storage and Supply System

The asphalt storage and supply system includes a 9,000-gallon bulk storage tank equipped with external steam heating panels. The temperature of the asphalt in the tank is maintained at approximately 300°F so that the asphalt in the tank is a pumpable liquid. The tank is insulated to reduce heat losses and a metal enclosure is provided around the tank for wind and snow protection. A three-hour fire wall is located between the asphalt tank and the auxiliary building addition, and a dike is provided around the tank to contain the asphalt in the event of a leak or overfilling of the tank.

A metering pump feeds the required amount of asphalt to the extruder/evaporator based on the type of radwaste being processed and the solids content of the waste. Feed of asphalt to the VRS system is interlocked with operation of the extruder/evaporator. The entire asphalt transfer system is supplied with steam heat tracing to maintain proper temperatures. The steam is supplied by an electric boiler.

Waste Collection and Feed System

The system is provided with the capability of collecting, concentrating and feeding bead resin. An evaporator concentrates pH adjustment and feed system is also provided. Connections for processing powdered resins are included with the VRS system. A spent filter handling system is not provided, but encapsulation of the filters with asphalt can be performed once the filters are delivered to the VRS system and placed in an empty container.

A spent bead resin tank is provided for handling resin slurries. The tank has useful capacity of 1,500 gallons. When used in conjunction with the existing resin storage tank, sufficient capacity exists for approximately one year's quantity of resin. The use of the two resin tanks also permits segregation of high specific activity resins from low specific activity materials and, therefore, more effective use of waste containers.

A positive displacement progressing cavity metering pump feeds controlled amounts of the resin slurry to the extruder/evaporator. The metering flow rate is established manually based on the composition of the waste stream. The asphalt flow rate is automatically adjusted to the proper ratio of asphalt to solids in the end product.

A positive displacement progressing cavity metering pump (P-119) feeds controlled amounts of evaporator concentrates from the recirculation line to the extruder/evaporator. All lines and components are electrically heat traced to maintain the fluid at 160°F to prevent crystallization of the waste salts in the system. Flushing connections are also provided to reduce radiation levels after a batch of concentrates has been processed. Concentrates feed is interlocked with operation of the extruder/evaporator, the asphalt feed system and the concentrates recirculation system.

Variations of pH will have little or no effect to the consistency or solidification of the final product. However, in order to minimize potential corrosion of all equipment, waste streams are adjusted to a pH of 7.0 to 9.3 prior to their introduction to the VRS system.

A pH monitoring system is provided in the concentrates recirculation line on the suction side of the concentrates metering pump. Caustic (25% solution is added to a recirculation loop on the discharge side of the metering pump in controlled amounts. The caustic will then be mixed with the waste stream in the concentrates tank. The batch addition of caustic will be continued until the required pH is achieved in the recirculation line, after which metering of the concentrates to the extruder/evaporator is permissible.

Extruder/Evaporator

Waste processing takes place in the extruder/evaporator. The lead materials (asphalt and waste) enter the extruder in the first barrel section where they are immediately combined by the mixing action of the intermeshing screws. The co-rotating twin crews are driven by a variable-speed motor within the range of 30 to 300r/min. The design of the screws, material selection and regulation of imposed torque have been developed considering processing efficiency and component wear.

Steam from an auxiliary boiler heats the extruder, thus heating the feed materials to a temperature sufficient to evaporate the free water in the waste feed. The steam input is controlled to maintain a conservatively safe temperature below the flammability point of asphalt. Several separate heat zones are provided along the length of the process section to provide for control of the evaporation process. As the water evaporates, the solids that remain in the extruder are kneaded to microscopic size particles which are individually coated and homogeneously dispersed in asphalt. The process section of the extruder/evaporator operates near ambient pressure. The asphalt/waste mix is continuously discharged into a container where solidification occurs as the mass cools. The free water evaporated from the wastes is condensed in the steam dome coolers which are integral parts of the extruder/evaporator. The condensed liquid is drained by gravity to the distillate collection system.

Container Filling System

The extruder/evaporator discharges the asphalt/radsalt mixture into standard 55-gallon carbon steel DOT drums. The empty drums are placed on a chain-driven roller conveyor system for filling. The conveyor is controlled to locate a drum directly beneath the extruder/evaporator port. Use of a reversible conveyor permits more than one pass filling without operator handling of containers during fill operations.

The filling operation can be monitored by the operator who has visual access through shielded windows and television cameras. Level in the drum being filled is monitored by two independent level detectors. The first detector indicates when a preselected drum level is reached and the second has two additional higher set positions. In this manner, the operator can terminate the filling of the drum at a prescribed level or allow the filling to continue until the level control system terminates filling. In addition, a timer cycle will provide for a sequential shutdown of the system if the fill cycle exceeds a preselected time period.

Container Handling System

The empty 55-gallon containers are manually placed on an accumulation section of an indexing chain conveyor. The drums are then fed by a pop-up roller transfer to a chain-driven roller conveyor. The roller conveyor positions an empty drum under the extruder/evaporator outlet. When full, the drum is moved on the roller conveyor to the cap and swipe station. This station has a rising support which rotates and automatically turns the drum during the swipe operation. The drums are finally removed from the conveyor and loaded onto pallets.

Vapor Control

Vapors in the fill area are removed via the ventilation hood installed around the extruder/evaporator discharge port. Air flow between the drum lip and vent hood periphery is maintained at 100 ft/min by the blower in the exhaust system. the vapors are passed over a mesh separator, an HEPA filter and a charcoal filter prior to being discharged through the normal Plant vent.

D. RADIOACTIVE WASTE STORAGE FACILITIES

Michigan has been denied access to the three existing burial sites.   Michigan has also been expelled from the Midwest Compact. The Palisades Plant will need to temporarily store radwaste until Michigan builds a disposal facility. It is assumed Palisades will have to store radioactive waste on site at least through 2007. It is proposed to use existing buildings at East and South locations as well as a new building at East location for the storage of radioactive waste.

Estimated Volumes and Activities

Approximately 2600 Curies of activity, dispersed in 2500 cubic feet of solid wastes are generated from the plant site in a normal year (i.e., a year in which there are no extended outages or major nuclear repair work being performed).

These wastes can be separated into the following categories:

	Ci/yr	Ft^3/yr
Expended Filter Cartridges	25	200
Dewatered Ion-exchange Resin-shielded	50	200
Solidified Evaporator Concentrates	10	300
Dry Active Waste	10	1000
Irradiated Hardware	2500	10
Dewatered Ion-exchange Resin-unshielded	0.1	800

Packaging

Solid wastes not being solidified by addition of immobilizing additives are processed as follows prior to offsite shipment:

1. Secondary side spent ion-exchange resin is packaged in 200 cubic foot steel liners, and dewatered in Auxiliary Building prior to shipment/storage.

2. Primary side spent ion-exchange resin is packaged in high integrity containers (HIC), dewatered in Auxiliary Building and transported/transferred in specially designed shipping casks.

3. Dry active wastes such as contaminated clothing, rags, paper, towels, gloves, shoe coverings, plastics, wood and metal could be compressed in to 94 cubic foot metal boxes by a B-400 Supercompactor, but preferably are shipped in sea-land containers to a vendor for volume reduction (incineration/supercompaction).

4. Expended filter cartridges are drained then transported to the shielded storage area in the East Radwaste building in specially designed casks. Filters are then transferred to HICs located in shielded vaults.

5. Irradiated hardware is dewatered in Auxiliary Building and stored.

6. Small amounts of liquid mixed waste and contaminated oil are stored in overpacks containing approved burial ground absorbents.

Facility Description

1. The East Radwaste Facility consists of two adjacent buildings connected by a shared roll-up door. radioactive waste (bags, filters, wood, metal, etc.) is transported to the East Facility to be processed. Dewatered resin and evaporator concentrates are packaged to meet criteria for dry waste prior to leaving the Auxiliary Building. The Dry Active Waste (DAW) is usually transported in a covered trash wagon used exclusively for this purpose.

The West building is currently used primarily for storage of cement rad vaults for storage of packaged resin and filter HICs. This building is also used for temporary storage of large contaminated or retired plant equipment awaiting processing or packaging.

The East building is primarily used for processing Dry Active Waste. The building is serviced by a 2000 cfm HEPA ventilation unit which is operated during processing operations. This building also has a separate (HEPA Ventilated) room for dismantling large contaminated components retired by the plant. This building is also equipped with a B-400 Supercompactor for compressing DAW. This compaction unit has a self-contained HEPA ventilation unit that provides location contamination control.

The East building also contains a built-in cement shielded vault system for storage of high level filters, resin and DAW. All items placed in the vaults for storage are packaged in High Integrity Containers to maintain a contamination free area. This vault system is sectioned into two areas, one with 24" of concrete shielding and the other with 36" of shielding which maintains area radiation levels to near background levels.

2. The South Radwaste building is a 40' x 80' engineered steel building. In January 1992 the main floor of the building was elevated 24 inches (18 inches compacted sand with 6 inches cement cap) to prevent water intrusion from flooding, cooling tower overflows or excessive rainfall.

   This building will be used only to store DAW in metal boxes and steel drums, incinerator ash in HICs and solidified evaporator concentrate in steel drums, packaged in accordance with NRC, DOT and burial site requirements. These metal boxes are to be stored around the outer walls of the main floor. Every box is equipped with risers (feet) to allow containers to be raised off the floor to prevent inadvertent water accumulation to cause external corrosion and possible degradation of container integrity. A series of 5" cement DAW rad vaults will be placed in the center section of the building to store solidified evaporator concentrate drums. The incinerator ash will also be stored in the center section of the building.

3. An additional building will have to be provided at the East Facility to handle the predicted volume of radioactive waste. It will be limited to storage only of waste packaged in accordance with NRC, DOT and burial ground requirements.

Radiological Consequences

1. Gaseous - Accident releases from the radioactive waste storage buildings are not considered credible because of material, packaging and steel and/or cement shielding. However, to show compliance with Generic Letter 81-38 criteria, three accident cases were run as well as direct dose calculations to the site boundary. The accident cases were a small fraction of 10 CFR 100 limits and direct dose to the site boundary was less than 1 mrem/yr as required by Generic Letter 81-38.

2. Liquid - There are no liquid effluent consequences in radwaste building because all waste in the building meets dry radioactive material status except for a small amount of liquid mixed waste and some contaminated oil. This waste will be over-packed with absorbent material and in no event could the criterion per 1E Circular 80-18 of MPC at the nearest water supply be approached.

Containers

These containers are selected based on structural strength, the ability to maintain container integrity during processing, packaging, storage and transportation. They will also demonstrate minimal corrosion effects from exposure to internal environment over a long period of time. All containers are stored inside the building to protect against corrosion from external environment. These containers comply with the requirements of 10 CFR 71 and 49 CFR as well as burial ground criteria to prevent the need for repackaging prior to shipment. HIC lids are equipped with passive vents to allow depressurization of hydrogen, but do not permit migration of radioactive material. Additional semi-portable cement rad vaults to shield filled HICs will be placed in East Radwaste Building on an as-needed basis. The solidified evaporator concentrate drums will be stored in semi-portable cement storage vaults at both South and East buildings.

Surveillance

Once every quarter radwaste containers in storage areas at the Radwaste Buildings are inspected for container integrity, proper labeling and contamination levels.

Monitoring Equipment

1. Area Monitors - All buildings at the east and the south building will contain an area monitor calibrated to read out in mR/hr (equivalent to mrem/hr). These area monitors provide local alarms and will initiate a phone alarm to the control room when dose rates in the area reach or exceed alarm set points.

2. Air Monitoring - The storage areas at the radwaste facilities are equipped with a continuous air monitor. This monitor has an adjustable visual and audible alarm. The air monitor alarm will also initiate a phone alarm to the control room.

Effluent Monitoring

The processing/sorting area at the east radwaste facility is equipped with a portable 2000 c/m ventilation unit with HEPA filter. The ventilation exhaust is equipped with a sample collection system. This system consists of a flow meter, vacuum pump and particulate filter sampler.

ALARA

Purification filter (F-54) activated incores and other higher level material will be stored in 36 inch concrete vaults in east building. Higher level DAW, resin (not T-104) and filters will be stored in 18 inch thick semi-portable concrete vaults. The design resin liner would have a 12 inch reading of 20.1 mrem/hr in the 18 inch vault. Concentrate asphalt drums will be stored in a five inch concrete vault. DAW boxes will be stacked with lower reading boxes on the outside to minimize dose outside the radwaste areas. These shielding materials and methods are provided to address ALARA principles and maintain low radworker exposure.

Volume Reduction

Volume reduction techniques are being used on a full time basis. An asphalt extruder is used to volume reduce evaporator concentrate waste. Our 400,000 lb ram force compactor is close to state-of-the-art. Wood planning and grit blasting are used to decontaminate wood and metal. Vendors process most trash and wood (incineration), some metal (smelting) and return unprocessable waste and residue to the site for storage. The waste returned will be packaged to meet NRC, DOT and burial site requirements prior to storage.

2.6.2.10 Callaway

A. LIQUID WASTE MANAGEMENT SYSTEMS

Several systems within the plant serve to control, collect, process, handle, store, recycle, and dispose of liquid radioactive waste generated as a result of normal plant operation, including anticipated operational occurrences. This section discusses the design and operating features and performance of the liquid radwaste system and the performance of other liquid waste management systems which are discussed in other sections.

SYSTEM DESCRIPTION

The LRWS collects, processes, and discharges or recycles reactor grade water entering the system. Equipment drains and waste streams are normally segregated to prevent the intermixing the liquid wastes. The liquid waste processing system (LWPS) consists mainly of two subsystems designated as drain channel A and drain channel B. Drain channel A normally processes all water which can be recycled. Drain channel B normally processes all water which may normally discharged. Potentially radioactive nontritiated waste (DRW) and detergent waste (SRW) drainage is discussed in Section 9.3.3 of the FSAR. A drain system is also provided inside the containment to collect drainage and leakage and transfer it to an appropriate tank.

The bulk of the radioactive liquids discharged from the reactor coolant system is processed by the boron recycle system. This limits input to the LWPS and results in the processing of relatively small quantities of generally low activity level wastes.

The various waste streams are processed as follows:

- Tritiated Wastes
- High Level Chemical Waste
- Controlled Access Area Floor Drainage
- Laundry And Personnel Decontamination Waste

<u>System Operation</u>

The LRWS operation is manually initiated, except for some functions of the reactor coolant drain subsystem. The system includes adequate control equipment to protect the system components and instrumentation and alarm functions to provide operator information to ensure proper system operation. All pumps in the system have low level shutoffs, and all filters, strainers, and demineralizers have differential pressure indication to indicate fouling.

Operation of the LRWS is essentially the same during all phases of normal reactor plant operation; the only differences are in the load on the system. The following sections discuss the operation of the system in performing its various functions. In this discussion, the term "normal operation" should be taken to mean all phases of operation, except operation under emergency or accident conditions. The LRWS is not regarded as a safety-related system.

REACTOR COOLANT DRAIN TANK SUBSYSTEM OPERATION - Normal operation of the reactor coolant drain subsystem is automatic and requires no operator action. The system can be put in the manual mode, if desired.

DRAIN CHANNEL "A" SUBSYSTEM OPERATION - Waste is accumulated in the waste holdup tank until a sufficient quantity exists to warrant an evaporator startup or to switch the evaporator operation from the floor drain tank to the waste holdup tank.

WASTE EVAPORATOR OPERATION - The waste evaporator is used to purify and degas high quality waste for recycling to the plant.

DRAIN CHANNEL "B" SUBSYSTEM OPERATION - Normally, one floor drain tank is aligned to receive the discharge from the floor and equipment drain system, while the other tank is being used to supply waste to the processing system. This procedure allows the waste to be sampled and pH adjusted, if desired, prior to processing, to ensure optimum system performance. Since the dissolved solids concentration is normally high, this waste is processed via the SLW evaporator or the waste evaporator.

LAUNDRY SUBSYSTEM OPERATION - Laundry waste from the washing machines and waste from the personnel decontamination showers are directed by gravity drain to the detergent drain tank located in the basement of the control building. This waste may be pumped to the laundry and hot shower tank (LHST) where it is sampled, prior to being processed by the SLW evaporator. If discharge of the LHST contents is desired and the tank contents are found to be of acceptable quality for discharge, the LHST fluid may be processed by the LHST filter and directed to the waste monitor tank "B" for discharge.

Floor drain wastes are relatively dirty and may contain moderately high radioactivity. Treatment of floor drain wastes prior to discharge may consist of evaporation, filtration and/or demineralization.

The chemical drain tank (CDT) receives chemically contaminated tritiated water from the plant sample stations, chemically contaminated decontamination wastes, and evaporator tube defouling chemicals. Contents of the tank are sampled, and normally drained to the floor drain system. Operation is intermittent and manually controlled. A high level alarm is provided from the CDT for operator information.

B. GASEOUS WASTE MANAGEMENT SYSTEMS

The gaseous radwaste system (GRWS) and the plant ventilation exhaust systems control, collect, process, store, and dispose of gaseous radioactive wastes generated as a result of normal operation, including anticipated operational occurrences. This section discusses the design, operating features, and performance of the GRWS and the performance of the ventilation systems. The plant ventilation exhaust systems accommodate other potential release paths for gaseous radioactivity due to miscellaneous leakages, aerated vents from systems containing radioactive fluids, and the removal of noncondensables from the secondary system. Systems which handle these gases are not normally considered gaseous waste systems and are discussed in detail in other sections. These systems are included here to the extent that they represent potential release paths for gaseous radioactivity.

SYSTEM DESCRIPTIONS

This section describes the design and operating features of the GRWS.

The main flow path in the GRWS is a closed loop comprised of two waste gas compressors, two catalytic hydrogen recombiners, six gas decay tanks for normal power service, and two gas decay tanks for service at shutdown and startup. The system also includes a gas decay tank drain collection, tank, drain pump, four gas traps to handle normal operating drains from the system, and a waste gas drain filter to permit maintenance and handle normal operating drains from the system. All of the equipment is located in the radwaste building.

For all buildings where there is potential airborne radioactivity, the ventilation systems are designed to control the release. Where applicable, each building has a vent collection system for tanks and other equipment which contains air or aerated liquids. The condenser evacuation system discharge is filtered and discharged to the unit vent in addition to the discharges from the reactor building, auxiliary building, and fuel building. The radwaste building, which houses the GRWS, has its own release vent. The turbine building has an open ventilation system, and the steam packing exhaust discharges into the turbine building.

The vent collection systems receive the discharge of vents from tanks and other equipment in the radwaste and auxiliary buildings which contain air or aerated liquids. These components contain only a very small amount of fission product gases. Prior to release via the radwaste or auxiliary building ventilation system, the gases are monitored, as described in Section 11.5, and passed through a prefilter, HEPA filter, charcoal filter, and another HEPA filter in series which reduce any airborne particulate radioactivity to negligible levels and provide a decontamination factor of at least 10 for radioactive iodines and 100 for particulates. Expected efficiencies for iodine removal are better than 99 percent for elemental iodine and 95 percent for organic iodine at 70-percent relative humidity. However, for gaseous effluent release calculations, 70-percent efficiency is conservatively used for radioiodine isotopes.

Although plant operating procedures, equipment inspection, and preventive maintenance are performed during plant operations to minimize equipment malfunction, overall radioactive release limits have been established as a basis for controlling plant discharges during operation with the occurrence of a combination of equipment faults of moderate frequency. These faults include operation with fuel defects in combination with steam generator tube leaks and malfunction of liquid or gaseous waste processing systems or excessive leakage in reactor coolant system equipment or auxiliary system equipment. Operational occurrences such as these can result in the discharge of radioactive gases from various plant systems. These unscheduled discharges may be from plant systems which are not normally considered gas processing systems or from a gas decay tank after a 60-day holdup period. If the holdup period restricts plant operation, it may be necessary to decrease this time with prior approval from the Superintendent, Health Physics.

C. SOLID WASTE MANAGEMENT SYSTEM

The solid radwaste system (SRS) is designed to meet the functional requirements of the solid waste management system. The SRS is designed to collect, process, and package radioactive wastes generated as a result of normal plant operation, including anticipated operational occurrences, and to store this packaged waste until it is shipped offsite to a licensed burial site.

Power Design Bases

POWER GENERATION DESIGN BASIS ONE - The SRS is designed to meet the following objectives:

a. Provide remote transfer and hold-up capability for spent radioactive resins from the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, liquid radwaste system, steam generator blowdown system, and secondary liquid waste system and for spent radioactive activated charcoal from the liquid radwaste system and the secondary liquid waste system.

b. Solidify and package concentrated waste solutions from the boron recycle, liquid radwaste, and/or secondary liquid waste evaporators, spent radioactive resin from the demineralizers, spent activated charcoal from the adsorbers, and spent filter cartridges.

c. Provide a means to semiremotely remove and transfer the spent filter cartridges from the filter vessels to the solid radwaste processing system in a manner which minimizes radiation exposure to operating personnel and the spread of contamination.

d. Provide a means for compacting and packaging miscellaneous dry radioactive materials, such as paper, rags, and contaminated clothing.

POWER GENERATION DESIGN BASIS TWO - The SRS is designed and constructed in accordance with Regulatory Guide 1.143, and Branch Technical Position ETSB 11-3.

POWER GENERATION DESIGN BASIS THREE - The SRS design parameters are based on the radionuclide concentrations and volumes consistent with reactor operating experience for similar designs.

POWER GENERATION DESIGN BASIS FOUR - Collection, solidification, packaging, and storage of radioactive wastes are to be performed so as to maintain any potential radiation exposure to plant personnel during system operation or during maintenance to "as low as is reasonably achievable" (ALARA) levels, in accordance with the intent of Regulatory Guide 8.8 in order to maintain personnel exposures well below 10 CFR 20 requirements. Design features incorporated to maintain ALARA criteria include remote system operation, remotely actuated flushing, and equipment layout permitting the shielding of components containing radioactive materials. Additionally, access to the solidification and solid waste storage areas is controlled to minimize personnel exposure.

POWER GENERATION DESIGN BASIS FIVE - The on-site storage facilities for drummed solid wastes have a capacity for temporary storage of solid wastes resulting from up to 5 years of plant operation. Temporary on-site storage and shipping offsite of solid radwaste do not present a radiation hazard to persons on-site or offsite, for either normal conditions or extreme environmental conditions, such as tornados, floods, or seismic events.

POWER GENERATION DESIGN BASIS SIX - The SRS is designed to meet the requirements of General Design Criterion 60 of 10 CFR 50, Appendix A. Packaging and shipment of radioactive wastes is performed in accordance with the requirements of 10 CFR 71, 49 CFR 173, and applicable state regulations.

SYSTEM DESCRIPTION

The SRS consists of the following subsystems:

a. Solidification system
b. Dry waste system
c. Resin handling system
d. Filter handling system

The activity of the influents to the SRS is dependent on the activities of the various fluid systems, such as the boron recycle system, secondary liquid waste system, liquid waste management system, chemical and volume control system, fuel pool cooling and cleanup system, floor and equipment drain system, and the steam generator blowdown system. Reactor coolant system activities and the decontamination factors for the systems given above also determine the influent activities to the solid radwaste system.

System Operation

Solidification System

The solidification system is designed to process the designated wastes resulting from normal plant operation, while operating for less than three 8-hour shifts per week, and is capable of continuous operation to meet anticipated transients which plan a greater-than-normal load on the solidification system.

Solids inputs to the solidification system, such as spent resins and charcoal, are sluiced to either the spent resin storage tank (primary) or spent resin storage tank (secondary), depending upon which component that supplied the waste.

Evaporator concentrates are stored in either the evaporator bottoms tank (primary) or the evaporator bottoms tank (secondary). Each tank is provided with a mixer, and the piping system contains a relatively high flow pump for recirculation of the tank's contents to maintain the concentrates in the homogeneous state. Each tank is supplied with external strip heaters, and all piping that can contain the concentrated waste is heat traced to preclude crystallization and eventual plugging within the piping system.

Solidification of process wastes is based upon formulas approved per the plant Process Control Program (PCP). The pretested formulas establish the system's process parameters and provide boundary conditions within which reasonable assurance is given that complete solidification (the lack of free water) has occurred. The boundary conditions for process parameters include mixing time, waste pH, major chemical substances, liquid waste-to-binder ratio, and solids-to-water ratio. The PCP establishes and defines the administrative controls which will be used and identifies the documentation necessary to ensure that the process is operated within the established boundaries.

Evaporator bottoms and other non-dewaterable waste streams may be reduced to dry solid form by a liquid volume reduction system designated as "RVR-800 Radioactive Liquid Volume Reduction system." This system is designed to provide the greatest volume reduction possible of liquid waste streams.

The RVR-800 is a 25 cubic foot capacity dryer using a steam heated and a rotating agitator/scraper assembly to dry the waste. The helical agitator/scraper assembly is driven by a 25 horsepower electric motor reduced to 20 rpm by a parallel gear reducer. All wetted surfaces are 304 stainless steel. A video camera is provided to observe the waste throughout the drying process.

Plant wastes are added to the RVR-800 through a plant waste supply line. Once the unit is full with the plant wastes, the liquid is then heated by passing steam through the external dryer jacket while being mixed by the rotating agitator. The steam vapor is pulled from the dryer through a condenser heat exchanger. This condenser is cooled by a 50 ton chilled water system. The condensate is routed to the condensate reservoir from which it can be delivered to plant drain systems and also used as the motive fluid for the system's jet pump. After the dryer has boiled down to a low level, the waste supply valve is opened and additional wastes are added to the blender/dryer as required.

The dry out phase begins with the end of the last addition of plant wastes. The dryness of the material is verified by monitoring several system parameters, as well as a visual observation through the site glass. Upon verification of dryness, the agitator helix moves the material to the pneumatically operated discharge valve located at the bottom center of the dryer shell. The material is discharged into the burial container using gravity.

The packaging enclosure, which houses the burial container, is kept under a negative pressure and vented through a HEPA system. This allows the operator to open the enclosure door to cap and wipe down the burial container without releasing contaminated particulate. The final product of some waste stream may be a dry fine powder. In other cases, a binding material can be added to the system prior to discharge. The material and binder are mixed for approximately 20 minutes before being discharged into the burial container.

Dry Waste System

Low-level dry active wastes are collected at appropriate locations throughout the plant, as dictated by the volume of these wastes generated during operation or maintenance. Dry wastes, which can be compressed to minimize the shipping volume, may be compacted in 55-gallon drums with a dry waste compactor or may be packaged in approved containers for offsite volume reduction. Compactors are located in the radwaste building, and auxiliary building. The dry waste compactors have an integral shroud which directs any airborne dusts created by the compaction operation through an exhaust fan and filter, and then to the respective building's ventilation system.

Packaged containers are sealed and moved to either the drum storage area in the radwaste building or to another approved storage location, where they are stored until shipment offsite.

Packaged, non-compacted, low-level dry active waste may be placed in cargo boxes, such as "Sealand," approved for shipping low-level radioactive waste by the DOT, located in staging areas adjacent to the radwaste building within a RPA. The filled shipping containers could be in this area for staging purposes for a year.

Large components and equipment which have been activated during reactor operation and which are not amenable to solidification or compaction are handled either by qualified plant personnel or by outside contractors specializing in radioactive materials handling, and are packaged in shipping containers or appropriate shipping packages of an appropriate size.

Dry noncompressible radwaste (such as hoses, buckets, etc.) will be packaged in D.O.T. approved shipping, containers and shipped as waste in accordance with applicable federal, state, burial site and/or processor requirements.

Resin Handling System

The resin handling system provides the capability for remote removal of spent radioactive resin and activated charcoal from the demineralizer and charcoal adsorber vessels in the chemical and volume control system, fuel pool cooling and cleanup system, boron recycle system, liquid radwaste system, steam generator blowdown system, and secondary liquid waste system and to transfer them to the associated spent resin storage tank.

In the resin transfer mode, the spent resin sluice pumps take suction from the storage tank via a screened connection on the tank and pump water through the respective vessel to first backflush the resin and then sluice the resin to the spent resin storage tank. Primary resin may be also sluiced from the demineralizer vessel to the primary spent resin storage tank with reactor makeup water. Steam generator blowdown resin may be sluiced from the demineralizer vessel to the secondary spent resin storage tank with steam generator system pressure. Steam generator blowdown resins may also be sluiced directly to the bulk waste disposal station with blowdown pressure. Positive indication that the resin has been sluiced to the spent resin storage tank is provided by an ultrasonic density element location in the spent resin sluice header.

The spent resin storage tank (primary), which accepts resins from the reactor purification systems, is capable of accommodating at least 60 days' waste generation at normal generation rates. The spent resin storage tank (secondary), which accepts spent resin and spent activated charcoal from the remaining vessels, is capable of accommodating at least 30-days' waste generation at normal generation rates.

Spent resin and spent activated charcoal are transferred from the spent resin storage tanks to the bulk waste disposal station by pressurizing the storage tank with nitrogen and supplying sluice water at the outlet nozzle on the tank for bulk waste processing.

The empty demineralizer or charcoal adsorber vessels are filled with clean resin or activated charcoal by gravity sluicing from the resin charging tank into the associated vessels. The filling operations are performed remotely from the vessels being filled.

Filter Handling System

The filter handling system is a semiremote system which provides the capability to remove spent radioactive cartridge filters from their filter housings and to transport them to the processing area in the radwaste building. The techniques used in the filter handling system considered the following:

a. Operator exposure
b. Time and manpower requirements

c. Potential for the spread of contamination
d. Potential for mechanical difficulties
e. Logistics for filter handling

The "semiremote" system, as the name implies, requires the operator to be in the proximity of the filters; however, they are protected by distance and shielding, which minimize operator exposure. The filter handling system and associated hardware will be utilized to maintain operator exposure ALARA; however, where radiation levels permit, filter cartridge changeouts may be performed utilizing manual changeout techniques. Determination of which changeout technique is to be utilized for a given cartridge changeout activity will be covered by established administrative controls.

The filter handling system consists of a working plug and a bell-shaped shielded transfer cask. The working plug is designed to fit in a hatch above the filter housing and has provisions for viewing the top of the filter housing and penetrations to allow long-handled tools to be used for the removal of the filter housing top. The bell-shaped shielded transfer cask is used to retract the spent filter cartridge from its housing and transport it to the processing area for drumming, where, the filters are dropped in prelined concrete drums and capped and are then stored in the drum storage area prior to shipment.

Bulk Waste Disposal

The disposal of spent resin, spent activated charcoal, and evaporator concentrates may require processing and packaging by means other than those provided by the installed solidification system. The bulk waste disposal station can be used in these instances.

Bulk waste disposal, as the name implies, involves the processing of large volumes of waste via bulk processing means for subsequent disposal.

Normally, wastes from either the spent resins storage tanks or evaporator bottoms storage tanks are first sampled and analyzed to determine the required processing method as well as the type of container to be utilized. The results of these analyses may also be utilized to determine required waste pre-conditioning and/or solidification formulation prior to transfer of the wastes to the bulk waste disposal station. In lieu of pre-sampling of wastes, in line transfer sampling can be used provided appropriate evaluations are performed prior to transfer to determine container type and processing required.

The bulk waste disposal station consists of a set of flanged connections installed in a common crossover leg of the solid radwaste system process piping through which either spent resin/spent activated charcoal from the spent resins storage tanks or evaporator concentrates from the evaporator bottoms storage tanks may be transferred.

Piping or hose connections are made between the bulk waste disposal station waste transfer flange and either a vendor processing skid or directly to an appropriate container such as a liner or a HIC. Hoses and/or piping utilized are subjected to pressure tests to verify leak-tight connections and adequacy of the hose or pipe to safety contain and transport the waste.

Wastes to be solidified/dewatered by contracted vendors are processed using approved vendor or plant procedures. Wastes are processed in vendor supplied containers using vendor processing equipment and systems.

Liners provided for bulk solidification incorporate large, vane type mixing blades for mixing of the waste and cement. The addition of cement and additives are recorded and monitored so as to ensure compliance with pre-determined waste solidification formulas.

Liners or HIC's provided for bulk dewatering of spent resins/spent activated charcoal incorporate a series of dewatering internals in lieu of the mixing blades mentioned above to ensure compliance with burial site criteria regarding free water within the disposal container.

Dewatering of vendor provided liners or HIC's may be performed by plant operating personnel and equipment provided the dewatering process and methods to verify complete dewatering are in compliance with vendor recommendations and applicable regulatory requirements.

Upon completion of bulk processing and packaging the liner or HIC is either stored on-site in an approved storage area or shielded storage container or shipped directly offsite for disposal.

Packaging, Storage, and Shipment

Spent resins, evaporator bottoms, spent charcoal, spent filter cartridges , and solid compactable wastes such as paper, rags, and clothing are packaged in approved containers, in accordance with 49 CFR, and shipped in shielded casks, as required to meet 49 CFR dose limitations.

The 55-gallon drums used in the solid radwaste system meet all the requirements for packaging, as specified by 49 CFR.

Packaged solid radwaste is normally stored in one of two locations, depending on the requirements for radiation shielding and the amounts of waste temporarily stored on site. These two locations are designated drummed and bulk solid radwaste storage locations. The storage location for drummed solid radwaste is an annex to the radwaste building, on the south side. Other containers of radwaste may also be stored in this area. This structure has concrete walls for radiation shielding. Within this structure are two storage areas, containing 550 and 1,180 square feet of usable floor area. These areas are shielded and remotely maintained to limit radiation exposure to operating personnel. On the basis of stacking the filled drums 5 levels high, the drum capacities of the two areas are 395 and 1,055 drums, pyramidal, or 585 and 1,365 drums, palletized.

Provisions for long term storage of solid radwaste at each site are described in Sections 11.4 of the Site Addenda.

Packaged solid radwaste in drums, HICs, LSA Boxes, etc., will normally consist of:

- Spent resins, primary
- Evaporator bottoms, primary
- Filter cartridges, primary
- Spent resins, secondary
- Evaporator bottoms, secondary
- Hazardous/chemical wastes
- Dry and compacted wastes

It is estimated that the maximum total of these wastes will be 923 drums per year (refer to Table 11.4-3). Based on this estimate, there is capacity in the radwaste building for approximately 2 years of drummed solid wastes.

The interim storage location for bulk solid radwaste is normally in the outside area adjacent to the drummed storage annex section of the Radwaste Building, on the Plant West side of the building, extending Plant South to the Discharge Monitoring Tank area. This storage area is provided with a concrete slab surface for placement of containers, and is enclosed by a fence with access gates, for control of access to the area. Packaged solid radwaste, in HICs, LSA Boxes, or DOT approved shipping containers are temporarily stored in this or other approved locations on site while awaiting shipment to an off-site treatment or disposal facility, or for radioactive decay prior to long term storage within a facility structure. Subject to off-site treatment or disposal facility availability, transportation vehicle availability, decay times, etc., staged packaged radwaste residence time in outside locations will normally be less than 6 months.

While no protection from the environmental elements is afforded to the packaged radwaste containers stored in outside locations, the storage period will normally be less than 6 months and the containers used for packaging these wastes are DOT approved containers for shipment. These containers are designed and manufactured to meet the conditions incident to shipping and disposal. On-site storage containers will be used for interim storage of high integrity containers. Temporary outside storage of the packaged radwaste containers for this short time period would have little or no deleterious impact on container integrity.

SAFETY EVALUATION

Packaged solid radwastes containing, or potentially containing, significant quantities of radioactivity (i.e., dewatered spent resins and solidified evaporator bottoms wastes) are in a form that is highly resistant to release and spread of radioactivity during an extreme environmental event, such as a tornado or earthquake. This configuration provides, in effect, a double barrier against the release of radioactivity.

The drums that require radiation shielding are stored in the radwaste building, which is resistant to tornados. These drums will remain in place during any extreme environmental event. The drums or other approved shipping containers for noncompacted, dry wastes, etc., stored outside in bulk storage have low specific activities and, thus, even if dispersed by a tornado do not posse a radiation risk to on site or off site personnel.

The drummed radwaste storage area protects the containers from rainfall and corrosion and flooding is not a potential concern in grade-level buildings at the Callaway site.

Although compacted and solidified wastes are expected to be stored on site for some period of time prior to shipment, normally no credit other than 30-day decay will be taken for radioactivity decay realized by such storage when filling containers for shipping in accordance with 49 CFR dose limitations. That is, once filled, containers can normally be shipped immediately, subject to availability of a disposal site, with the proper shielding, without exceeding Department of Transportation radiation limits. If 49 CFR dose limitations cannot be met with the available shielding, however, the applicable containers are stored in appropriate storage areas until the doses are acceptable for shipping in accordance with Department of Transportation requirements.

The minimum on-site residence time for low level solid radwaste prior to shipping, such as dry compacted waste, steam generator blowdown spent resins, evaporator bottoms, and spent charcoal, ranges from several days to a few months. The minimum on-site residence time for solid radwaste prior to shipping, such as primary spent resins and spent filter cartridges from the primary system, ranges from a few months to a few years. Onsite residence time is based on the initial activity of the container, the time required to have sufficient containers to completely load a transporting vehicle, the thickness of the shields available, the number of containers which can be stored in the available shipping casks, the availability of a transporting vehicle, and the availability of ultimate disposal facilities.

All solid radwaste is shipped from the site in Department of Transportation-approved containers by Department of Transportation-approved carriers. Containers with any significant surface dose rate are moved remotely from the shielded storage areas to the transporting vehicle.

Radiation measurements made at the time of shipment of any radioactive waste material ensure that all shipments leave the site well within prescribed limits. Similarly, external contamination measurements are made to detect any potential release of radioactive material from the container prior to shipment.

2.6.2.11 Cooper

A. RADIOACTIVE WASTE SYSTEMS

<u>SUMMARY DESCRIPTION</u>

The radioactive waste systems collect, treat, and dispose of radioactive and potentially radioactive wastes in a controlled and safe manner such that the operation and availability of the station is not limited. The radioactive waste system includes equipment, instrumentation, and operating procedures which ensure that radioactive wastes may be safely processed and discharged from the station within the limits set forth in 10 CFR 20, 10 CFR 50, Appendix I, and 40 CFR 190.

The radioactive input to the radwaste systems is due primarily to (1) activation products resulting from irradiation of the reactor water and impurities therein (principally metallic corrosion products) and (2) fission products resulting from defective fuel cladding or uranium contamination within the reactor system.

Radioactive wastes resulting from station operation are classified as liquid, gaseous, and solid. The following definitions apply to radioactive wastes:

1. Liquid Radioactive Wastes -- Liquids directly from the reactor process and auxiliary systems or liquids which can become contaminated due to contact with these liquids from reactor process systems.

2. Gaseous Radioactive Wastes -- Gases or airborne particulates vented directly from reactor and turbine equipment containing radioactive material.

3. Solid Radioactive Wastes -- Solids from the reactor or auxiliary systems, solids in contact with reactor or auxiliary systems operations or those materials processed through the radwaste system and solidified.

B. LIQUID RADWASTE SYSTEM (NOT AUGMENTED)

Operational Objective

The liquid radwaste system collects, treats, and returns processed radioactive liquid wastes to the plant for reuse. Treated radioactive wastes not suitable for reuse are discharged from the plant as releases or packaged for offsite disposal.

Operational Design Basis

The liquid radwaste system is designed so that liquid radwastes are discharged from the plant within the limits specified in 10 CFR 20, 10 CFR 50, Appendix I, and 40 CFR 190, and the operation or availability of the plant is not limited.

Safety Design Basis

The liquid radwaste system is designed to prevent the inadvertent releases of liquid radioactive material from the exclusion area of the plant so that resulting radiation exposures are within the guideline values of 10 CFR 100.

Description

The liquid radwaste system for the Cooper Nuclear Station was designed to accept process wastes from two nuclear units. It is thus larger than would normally be necessary for the single unit currently in operation. The liquid radwaste system collects, processes, stores, and disposes of all radioactive liquid wastes.

Included in the liquid radwaste system are the following components/systems:

a. Piping and equipment drains carrying potentially radioactive wastes;

b. Floor drain systems in controlled access areas and/or those areas which may contain potentially radioactive wastes;

c. Tanks, piping, pumps, process equipment, instrumentation and auxiliaries necessary to collect, process, store, and dispose of potentially radioactive wastes; and

d. Tanks and sumps used to collect potentially radioactive wastes.

Equipment was selected, arranged, and shielded to permit operation, inspection, and maintenance with acceptable personnel doses. For example, sumps, pumps, valves, and instruments are located in controlled access areas. Tanks and processing equipment which can contain large quantities of liquid radwastes are shielded. In addition, the radwaste equipment was selected for a minimum of maintenance. Operation of the waste system is essentially manual start-automatic stop.

The radwaste system is divided into several subsystems so that the liquid wastes from various sources can be kept segregated and processed separately. Cross connections between the subsystems provide additional flexibility for processing of the wastes by alternate methods. The liquid radwastes are classified, collected, and treated as either high purity, low purity, chemical, or sludges. It should be noted that the terms “high” purity and “low” purity refer to conductivity and not radioactivity.

High Purity Wastes

High purity (low conductivity) liquid wastes which are collected in the waste collector tank are from the following sources:

1. Drywell equipment drain sump
2. Reactor building equipment drain sump
3. Radwaste building equipment drain sump
4. Turbine building equipment drain sump
5. Reactor cleanup system
6. RHR System
7. Decantate from cleanup phase separators
8. Decantate from condensate phase separators
9. Centrifuge effluent
10. Fuel pool system
11. Waste Sludge Tank

The waste from the equipment drains identified above are also high level wastes (as well as being high purity wastes). The average high purity waste collected is 16,000 gallons/day with an average activity level of 1 x $10^4 \mu$Ci/ml.

Low Purity Wastes

Low purity (high conductivity) liquid wastes which are collected in the floor drain collector tank are from the following sources:

1. Drywell floor drain sump
2. Reactor building floor drain sumps
3. Radwaste building floor drain sumps
4. Turbine building floor drain sump
5. Chemical waste tank
6. Laboratory drain tanks
7. Elevated Release Point sump
8. Augmented Radwaste Building floor drain sump
9. Waste Sludge Tank (only when Waste Collector Tank is full)

These wastes generally have low concentrations of radioactive impurities, therefore, processing consists of filtration and subsequent transfer to the floor drain sample tank for sampling and analysis. If the analysis indicates that the concentration of radioactive contaminants is sufficiently low, the sample tank batch is transferred to the circulating water discharge canal for dilution with condenser circulating water as necessary to meet the plant effluent discharge requirements. Because no radium-226 or radium-228 of plant origin will be present, and because the potential concentration of iodine-129 is very low, the discharge concentration limit of $10^4 \mu$Ci/ml above background. If other radioisotopes are shown not to be present in significant concentrations, or if analyses are made, discharge limits may meet maximum permissible concentrations.

Chemical Wastes

Chemical wastes are collected in the chemical waste tank and laboratory drain tanks and are from the following sources:

1. Shop decontamination solutions
2. Laboratory drains
3. Reactor and Radwaste Building decontamination drains
4. Cleanup precoat tank drains
5. Multi-purpose facility floor drains [16]

The chemical wastes are normally comprised of laboratory drains. Infrequently (every several years) decontamination solutions may occur due to equipment decontamination for maintenance. The multi-purpose facility floor drains will provide some of this solution due to decontamination of equipment in the machine shop. The maximum activity and volumes are due to the decontamination solutions.[16]

Chemical wastes are of such high conductivity (ionic content) as to preclude treatment by ion exchange. The wastes are neutralized, if necessary, using caustic or sulfuric acid as the neutralizing medium. Normally these wastes are then sent to the floor drain collector tank and processed by batch filtration through the floor drain filter, followed by collection and sampling in the floor drain sample tank. The flow rate for the laboratory drain tanks to the floor drain collector tank is 38 gpm. A DF of 10 is expected in passing through the floor drain collector filter. After being shown suitable for disposal, the waste is diluted into the circulating water discharge canal at a rate to be within the unidentified mixture concentration limit of 10 CFR 20.[1]

If the radioactivity content of the waste precludes disposal by this route, the chemical wastes are processed through the liquid concentration system and disposed of as solid radwaste in 55 gallon drums or processed using an approved vendor method.

Corrosion of laboratory drains through the normal use of acids is minimized by recirculating used portions of samples to waste at the sample station. In effect this retains the sample in the system until it is satisfactorily neutralized. Reactor water, condensate and feedwater samples which do not need to be neutralized are routed to the high purity waste subsystem where the water is recovered for reuse.

Sludges

Expended filter-demineralizer ion exchange resins are removed when necessary by backwashing. Clean up system sludges and condensate system sludges are collected in phase separators where excess backwash water is removed by decantation and the sludge is accumulated for processing and consequently the radioactivity level decay. The fuel pool filter demineralizer and waste filters are backwashed to the waste sludge tank.

Clean up sludges, condensate system sludges, and waste and fuel pool sludges are kept separate because of the variation in radioactivity material content. This approach minimizes shielding requirements during shipping of the solid wastes.

Detergent Wastes

Detergent wastes are run through the floor drain collector and filtration system.

Safety Evaluation

The radwaste building is located on the north side of the reactor building, about 600 feet from the Missouri River. All the radwaste tanks contained in this structure are located below ground level. The clean-up phase separators, which are part of the radwaste system, are in the reactor building, which will contain their contents in the event of their failure. In the remote event of an earthquake of sufficient magnitude to damage the tanks in the radwaste building the tank liquids are located below grade to minimize the effects of such an event (see Chapter XII). Since the radwaste building and tanks are designed to withstand a Class I seismic occurrence, the possibility that the water may escape the building and run out into the ground through cracks is remote. Some of the tanks, condensate phase separators and waste sludge tank are contained in vaults so escape paths would only be through floor drain piping. Thus, the contents of these tanks will be retained unless cracks develop in the mat. Even then, the solids will be retained. Additionally, there is a 40 mil plastic membrane that completely encloses the radwaste building walls and mat that is intended to prevent loss of radioactive liquids.

Although these tanks are normally only partially full and at concentrations less than indicated, the following analysis assumes them to be full and at design basis concentrations. It also assumes all liquid contents are lost. If all the waste liquids escape from the radwaste building and enter the river over a period of an hour without absorption by the intervening ground, then $4.4 \times 10^{-7} \mu$Ci could enter the river. The minimum daily river flow in winter is currently maintained at 6,000 cubic feet per second. The average concentration of the radioactivity discharged into this flow in an hour would be $7 \mathrm{x} 10^{5} \mu$Ci/ml. Assuming the maximum permissible concentration of this mixture is the most limiting one of Table IX-2-2, i.e., $1.4 \times 10^{-6} \mu$Ci/ml, the maximum contribution to annual radiation dose to individuals due to this event would be three mrem. Actual contribution due to lesser volume, higher river flow, or lower radioactivity content would be less. The annual radiation dose permitted by 10 CFR 20 is 100 mrem per year. The maximum of three mrem contributed by an event such as described would amount to 3% of that permitted. Thus, it is concluded that the safety objective is met.

USAR

The radioactive liquid effluents from the station are controlled on a batch basis with each batch being processed by such method or methods appropriate for the quality and quantity of materials determined to be present. Those batches in which the radioactivity concentrations are sufficiently low to allow release to the circulating water discharge canal are diluted with condenser circulating water in order to achieve the allowable concentrations set forth in 10 CFR 20. The radioactive liquids are sampled and analyzed for gross or isotopic radioactivity prior to release to the discharge canal, thus providing information on effluents to be released so that appropriate release rates will be established.

Information from the effluent batch sample and laboratory analysis is sufficient to insure that the limits of the applicable regulations are not exceeded.

C. GASEOUS RADWASTE SYSTEM (NOT AUGMENTED)

Operational Objective

The gaseous radwaste system collects and processes gaseous radioactive wastes from the main condenser air ejectors, the startup mechanical vacuum pump, the gland seal condensers, and other minor sources, and controls their release to the atmosphere through the elevated release point (ERP) in such a way that the operation and availability of the station is not limited.

Operational Design Basis

1. The gaseous radwaste system is designed so that gaseous and particulate radwastes are processed and discharged such that operation and availability of the station are not limited.

2. The gaseous radwaste system is designed to minimize the possible explosion hazard of the hydrogen and oxygen present.

Safety Design Basis

1. The gaseous radwaste system is designed to include equipment, instrumentation, and operating procedures such that the gaseous radwastes discharged from the ERP to the environment will not exceed the limits set forth in the ALARA requirements of 10 CFR 50, Appendix I.

2. The gaseous radwaste system is designed to provide isolation on high off-gas radioactivity level.

3. The gaseous radwaste system is designed to maintain its integrity for all expected operating conditions by conservative process design.

Description

The gaseous radwaste system includes the subsystems that process and dispose of the gases from the main condenser air ejectors, the startup mechanical vacuum pump, and the gland seal condensers. The processed gases are routed to the ERP for dilution and elevated release to the atmosphere. The air ejector discharge and the ERP are continuously monitored by radiation monitors.

AUGMENTED OFF-GAS TREATMENT SYSTEM

Operational Objective

It is the function of the Augmented Off-gas Treatment System to further delay the radioactive gases in the off-gas stream, reducing the activity level, prior to venting to the atmosphere. This system was added so that the as low as practicable requirement of 10 CFR 50 would not be exceeded. The off-gas stream is intercepted after passage through the 48 inch delay pipe.

D. SOLID RADWASTE SYSTEM

Operational Objective

The operational objective of the solid radwaste system is to collect, process, package, and provide temporary storage facilities for solid wastes prior to shipment for off-site disposal.

Operational Design Basis

1. The system provides collection, processing, packaging, and storage of solid wastes resulting from normal station operations.

2. The system provides a safe and reliable means for handling solid wastes and to minimize radiation exposure to station personnel.

Safety Design Basis

1. The solid radwaste system includes equipment, instrumentation, and operating procedures such that the solid radwastes collected and prepared for off-site shipment in shielded casks, if required, will not result in radiation exposures in excess of the limits set in NRC or DOT regulations.

2. Shielded casks are provided as necessary to conform with 10 CFR 71.

Description

The solid waste processing areas are located in the radwaste and augmented radwaste buildings and process both wet and dry solid wastes. Wet solid wastes include backwash sludge wastes from the reactor water cleanup system, the condensate filter demineralizer system, the fuel pool filter demineralizers, the floor drain filter, the waste collector filter, and spent resins from the waste demineralizer. Dry solid wastes include rags, paper, equipment parts, solid laboratory wastes, etc.

The function of the solid radwaste system is to reclaim the liquid phase of the wet solid wastes for reuse within the station and to prepare the solid waste for off-site shipment with minimum exposure of the operators to radiation.

Radwaste Disposal System for Reactor Cleanup Sludge

System Function

The purpose of the radwaste system for cleanup sludge is to process the highly radioactive backwash waste which is discharged from the reactor water cleanup system.

The reactor water cleanup system includes two filter-demineralizer units each of which are precoated with a mixture of powdered ion exchange resin and a filter aid which are in turn retained on a permanent, stainless steel septum. These filter-demineralizer units remove, by filtration and ion exchange, the suspended and dissolved solids, both radioactive and stable, from the circulating reactor water. Upon exhaustion of either its filtration or ion exchange capability, the exhausted cleanup demineralizer is taken out of service and backwashed and precoated anew. The backwash waste as discharged from a cleanup demineralizer is a relatively dilute slurry (0.5% by weight suspended solids) which is highly radioactive. The backwash waste slurry is accumulated in the cleanup phase separators for hold-up and sludge precipitation. The waste is then periodically transferred on a batch basis to the centrifuges or the dewatering system for subsequent processing.

System Description

The backwash discharge from the cleanup filter demineralizers is collected and concentrated in two 4,500 gallon cleanup phase separators which are located below the cleanup demineralizers in the reactor building. After several backwashes are accumulated, the concentrated waste is transferred to the centrifuges or the dewatering system for dewatering.

The cleanup phase separators are designed to concentrate the sludge from 0.5 weight % solids to 5 weight % solids by sedimentation and decantation of the supernatant. While the working separator is filling, the other previously filled tank is held isolated to allow additional decay of sludge activity.

After each backwash batch is received by the working separator, it is allowed to settle for a period of time and the decantate is then transferred by pumping to the waste collector tank. When sufficient sludge has accumulated, the working separator is isolated and the sludge is fluidized to the 5% (by weight) slurry and transferred by pumping to the centrifuges or the dewatering system for dewatering. The cleanup phase separators are Class I seismic. All other equipment is Class II seismic.

Radwaste Disposal System for Condensate Filter Demineralizer Sludge

System Function

The purpose of this system is to process the radioactive backwash waste which is discharged from the condensate filter demineralizer system.

The condensate filter deminerlizer system includes six (6) filter demineralizer units, each of which is precoated with powdered ion exchange resin. These filter demineralizer units remove by filtration and ion exchange, the suspended and dissolved solids, both radioactive and stable, from the reactor feedwater condensate. Upon exhaustion of either its filtration or ion exchange capability, the exhausted demineralizer is taken out of service and backwashed and precoated anew. The backwash waste as discharged from a condensate demineralizer is a relatively dilute slurry (0.5% weight suspended solids) which is radioactive. The backwash waste slurry is accumulated in the condensate backwash and transfer tank from which it is transferred after each backwash procedure to the radwaste disposal system for subsequent processing.

System Description

The backwash discharge from the condensate filter demineralizers is collected in the condensate backwash and transfer tank which is located below the condensate filter demineralizers in the radwaste building. After collection, the waste is transferred by pumping to one of the two condensate phase separators for processing.

Operation of the condensate phase separators is similar to that for the cleanup phase separators (see Section IX-3.4.2.2 of the FSAR). Backwash sludge is received at 0.5 weight % solids and concentrated to 5 weight % solids, allowed to stand and then transferred by pumping to the centrifuges or the dewatering system for dewatering. The condensate phase separators are Class I seismic; all other equipment is Class II seismic.

Radwaste Disposal System for Fuel Pool, Floor Drain, and Waste Collector Filter Sludge

System Function

The purpose of this system is to collect backwash sludge wastes from the fuel pool, floor drain, and waste collector filter demineralizers for batch transfer to the centrifuges for dewatering.

System Description

Backwash sludge wastes from the fuel pool, floor drain, and waste collector filter demineralizers are drained by gravity to the waste sludge tank which is located in the radwaste building. Provisions are incorporated in the waste sludge tanks for the addition of flocculent, if required. These waste sludges are transferred on a batch basis by pumping to the centrifuges or the dewatering system for dewatering. The sludges are a relatively dilute slurry of 0.5 weight % of suspended solids. Piping is also provided to pump the wastes to the condensate phase separators for additional concentration of the sludge for flexibility. All basement tanks are Class I seismic; all other equipment is Class II seismic.

Spent Resin and Miscellaneous Solid Waste System

System Function

The purpose of the spent resin and miscellaneous solid waste systems is to temporarily store spent resins and miscellaneous solid wastes (rags, used clothing, paper, air filters, etc.) on the site in shielded areas as required prior to off-site shipment to a licensed burial ground.

System Description

Spent Resin System

Spent resin from the waste demineralizer is sluiced into a 2,000 gallon spent resin tank.

The waste demineralizer contains 80 cubic feet of mixed resins which will not be regenerated. Expected spent resin volume is approximately 240 cubic feet per year.

After each spent resin batch is discharged to the spent resin tank, the spent resins will be pumped from the tank to the centrifuges or the dewatering system for dewatering. The spent resin tank is Class I seismic.

Miscellaneous Solid Waste System

Dry, solid, radioactively contaminated waste such as glass, paper, plastic, metal, dirt, wood, cloth and grit are shredded and compacted into 45 cubic foot crates by a high force shredder/compactor or, are compacted in 55 gallon drums with a hydraulic compactor. The processed solid wastes are transferred to a temporary storage area until sufficient waste is collected for shipment to a licensed radioactive waste burial site.

The preferred method of processing dry radioactive waste (DAW) is with the high force shredder/compactor, due to the high waste volume reductions obtained by the system. The shredder/compactor system includes a hydraulic system, return rotary shredders hydraulic ram and compactor, conveyor and HEPA exhaust system. After monitoring, inspection and sorting, the DAW is placed on the shredder/compactor conveyor which carries the waste into the shredder followed by hydraulic compaction and final transfer into a 45 cubic foot DAW box. The DAW box is then sealed, surveyed and moved by forklift to a temporary storage area. The shredder/compactor is equipped with its own HEPA exhaust system. Exhaust air is collected in the DAW loading area as well as the shredder/compaction area. The shredder/compactor ventilation exhaust air is vented to the MPF ventilation system.

The alternate method of processing DAW is with the hydraulic compactor. The hydraulic compactor includes the hydraulic pump with motor, hydraulic oil storage, high efficiency filter, fan and accessories. The hydraulic compactor is designed to compress the wastes in the drum at 50 psi over the open area of the drum.

During compression, ventilation air is pulled across the top of the drum through high efficiency filters by a fan.

Compacted solid wastes in a standard 55 gallon drum are transferred to a temporary storage area.

Radwaste Disposal Systems for Wet Solid Wastes

System Function

Two systems are available for processing wet solid wastes: (1) the Cement Solidification System and (2) the Resin Dewatering System. The purpose of these systems is to process the waste sludges from the reactor water cleanup system, the condensate filter demineralizer system, the waste sludge tank effluent, and the spent resins from the waste demineralizer. The systems concentrate the bulk volume of the wet solid wastes, prepares this concentrated waste for off-site shipment, and reclaims the liquid phase of the wet solid wastes for reuse within the station.

Cement Solidification System Description

Sludge and resin wastes are received from the cleanup phase separators, the condensate phase separators, the waste sludge tank, and the spent resin tank and are reduced in volume by dewatering in either one of two centrifuges which are located in the radwaste building. Water effluent from the centrifuges is transferred to the waste collector tank for reprocessing and reuse in the station. The solid wastes are discharged from the centrifuges by gravity into their respective hoppers which are used for filling standard 55 gallon drums for ultimate disposal.

Cement is added to the drums to achieve solidification criteria. Drums partially filled with cement are brought into the shielded loading area one at a time by a loading conveyor. The drum is transferred to a floor-mounted primary transfer car which places the drum under the hopper to be used. After partial filling within the sludge the drum is transferred to the secondary transfer car and sent to the cement mixing station for the addition of water. Then the drum is transferred back to the primary transfer car for capping and sealing. The drum is then transferred back again to the secondary transfer car and is given a surface-wipe test for determination of surface contamination, is spray-washed, if necessary, and then transferred back to the primary car. It is then sent to one of the six (6) shielded storage conveyors for ultimate off-site disposal. All drum processes are performed remotely in ventilated shielded areas to provide minimum exposure of operators to radiation.

Resin Dewatering System Description

The Pacific Nuclear Systems, Inc./Nuclear Packaging, Inc. Resin Drying (Dewatering) System processes powdered and bead type ion exchange resins and other filter media by removing the excess water from the resins. This is accomplished in a three step process. First, the liner is filled from the plant’s waste tanks using excess water to keep the resin in a slurry and recirculating the waste tank so that a homogeneous mixture is achieved in the liner. During this transfer, the liner will be dewatered so that the available space in the liner is filled with resin to the maximum extent practicable. Second, the excess water is pumped out of the liner using a positive displacement diaphragm pump. Third, when all of the pumpable water is removed, the blower is started to recirculate air through the resin. The blower heats the air and as the warm air passes through the resin it entrains and vaporizes moisture in the resin bed. This moist air is pumped through the entrainment separator tank where refrigeration coils condense the water vapor in the air stream and any entrained water is removed. The water is pumped out of the tank using a diaphragm pump. The air is recirculated through the resin for a specified period of time. After this period of time, the percent relative humidity of the air stream should be at or below the required value indicating the resin bed is dry. The system is then shut down, the fillhead removed and the container capped. The container is given a surface-wipe test for determination of surface contamination and then loaded for off-site disposal. All processes are performed remotely in ventilated shielded areas to provide minimum exposure of operators to radiation.

2.6.2.12 Fort Calhoun

A. RADIOACTIVE WASTE DISPOSAL SYSTEM

Design Bases

The radioactive waste disposal system (RWDS) is designed to protect plant personnel and the public from exposure to radioactive wastes in accordance with 10 CFR Part 20; 10 CFR 50, Appendix I; 40 CFR Part 190; 10 CFR 50 Appendix A General Design Criteria 60, 63, and 64; 10 CFR 50 Appendix B for reviews and audits; and the intent of NUREG-0472, Draft Revision 3.

The RWDS has been reviewed against the requirements of NUREG-0472, Draft 7 of Revision 3, “Standard Radiological Effluent Technical Specifications (RETS) for Pressurized Water Reactors.” As a result of the review, Technical Specifications were approved to govern effluent instrumentation calibration and operation, allowable dose rates, approved methodology to calculate dose rates, limiting conditions for operating the RWDS, requirements for environmental monitoring programs and requirements for maintaining records, ensuring adequate review and audits and reporting information as required. The details of RETS commitments for the liquid, gaseous and solid radioactive treatment systems are discussed below.

The RWDS includes equipment to collect, store, process and treat as required, monitor, and dispose of liquid, solid, and gaseous radioactive wastes.

The RWDS is designed to process and remove radioactive wastes from the plant adequately and safely when 1 percent of the core fuel elements have failed and corrosion and fission product concentrations in the reactor coolant are at design values.

B. LIQUID WASTE PROCESSING SYSTEM

Sources and Characteristics of Liquid Wastes

The liquid waste collection and storage system is divided into three sections: hydrogen bearing reactor coolant liquids, auxiliary systems process wastes, and hotel wastes.

Hydrogen Bearing Reactor Coolant Liquids

The principal sources for these liquids are:

a. Chemical and volume control system bleed for boron control;
b. Volume control tank relief and drains;
c. Pressurizer quench tank drains;
d. Reactor coolant loop drains;
e. Equipment drain header.

These liquids vary in composition, but approximate the reactor coolant in both chemical composition and activity.

Fuel transfer canal drains and safety injection system drains also enter the collection system, although they are not hydrogen bearing reactor coolant liquids. These liquids and the hydrogen bearing reactor coolant liquids are collected in three nitrogen blanketed tanks: the reactor coolant drain tank, the auxiliary building sump tank and the neutralization tank.

Auxiliary Systems Process Wastes

The principal sources for the liquids are:

a. Spent regenerate from decorating demineralizers;
b. Auxiliary building floor drain header;
c. Auxiliary building sump flows;
d. Laboratory and decontamination area drain header;
e. Spent resin sluice water;
f. Monitor tanks contaminated return flows;
g. Waste holdup tank relief valves;
h. Steam generator blowdown and secondary side drains (contaminated flows only);
I. Containment building sump flows;
j. Radioactive Waste Processing Building Sump Flows;
k. Chemical and Radioactive Protection Building Laboratory drains.

Wastes from these sources are subject to contamination by reactor coolant. The drained liquids may be aerated prior to entering the waste disposal system and therefore, these wastes are collected in tanks that are not vented to the closed gas (nitrogen blanketed) circuit, due to possible oxygen contamination of the circuit. They are collected in the spent regenerant tanks which are vented to the auxiliary building ventilation system.

Aerated Domestic Wastes

The principal sources for these liquids are:

a. Laundry facility drains;
b. Shower drains;
c. Hand sink drains.

These wastes all originate in the auxiliary building an dare transported in the laundry drain header which discharges to the hotel waste tanks. Aerated domestic wastes are normally low in activity.

Liquid Waste Treatment

The RWDS is designed to provide filtration, evaporation, and demineralization in any combination, as needed to ready the waste for ultimate disposal.

Filtration

Suspended solids are removed by two waste filters. Solids are retained on the disposable filter element. Filter effluent is directed to the next treatment step or to the monitor tanks.

Evaporation

The waste evaporator can receive liquids from one of two sources: the inlet treatment header or the waste filters. The dissolved and suspended solids in the feed, some containing radioactivity, are concentrated in the bottom of the evaporator and are pumped to either the concentrate tanks or the drumming station.

The vapor discharged from the top of the evaporator is condensed, cooled, and then directed to the monitor tanks. This condensate is not highly radioactive and can normally be pumped from the monitor tanks to the overboard header following mixing and analysis.

The evaporator is operated at a pressure of 1 to 2 psig and a temperature of 215 to 220^{o}F. It is equipped for the addition of an anti-foaming agent.

Filtration/Ion Exchange

Filtration/ion-exchange (FIX) services are presently being used as the preferred method for liquid waste treatment and is located in the Radioactive Waste Processing Building. The FIX system is designed to remove specific radioisotopes in the liquid waste stream. The treated effluent from the FIX system is transferred to the monitor tanks.

Concentrate Tanks

Two tanks are provided and have the function of storing concentrate (bottoms) from the waste evaporator prior to release to the drumming station. The tanks are constructed of carbon steel, both of which have been coated with a resin base paint that is resistant to boric acid. Storage at this point permits scheduling of concentrate drumming operations and also permits the monitoring and adjustment of concentrate activity in accordance with drum shielding requirements.

The tanks and adjacent piping are electrically heat traced to prevent boric acid recrystallization. On filling, these tanks are vented to the auxiliary building ventilation exhaust system. During depletion, atmospheric air is drawn in. Two manually controlled concentrate pumps deliver the concentrate to the drumming area.

Monitor Tanks

The two monitor tanks normally receive processed liquid wastes from the waste holdup tanks. The wastes are sampled and analyzed isotopically to confirm acceptability for controlled release to the overboard header. One tank can be undergoing recirculation for sampling while the other tank is being released to the overboard header.

Waste Demineralization

The principal function of the two waste demineralizers, which are not operational, is to offer an alternate method to evaporation where only a small degree of decontamination is required. These demineralizers do not treat waste directly from the treatment inlet header, but are arranged to handle batches of waste from the monitor tanks only. Effluent from the demineralizers returns to the monitor tanks and cannot be routed elsewhere.

The demineralizers are of the mixed bed type, are nonregenerative, and completely disposable. They have provisions for venting back to the monitor tanks and of dewatering at the end of the run.

When the resin becomes exhausted, the demineralizer is disconnected from its three lines (inlet, outlet, and vent) by remote air operation of the disconnects. The complete demineralizer is then disposed of as a solid.

Liquid Waste Disposal

During releases of radioactive liquid waste, the equipment and conditions shall be in accordance with the ODCM. The doses resulting from liquid releases shall not exceed, during any calendar year, 3 millirem to the total body (10 millirem to any organ) as required y 10 CFR Part 50 Appendix I.

The requirements for sample monitoring and testing prior to release and the requirements to ensure monitors are calibrated are included in the ODCM. Records of liquid releases must be maintained and are subject to the review, audits, and reporting requirements discussed in Section 11.3 of the FSAR.

The overboard header is the only path through which the liquid rad wastes can be released from the containment, auxiliary, Radioactive Waste Processing and CARP buildings. It receives liquid from the monitor tanks, the hotel waste tanks, or blowdown from the steam generators. The overboard header originates at the monitor tanks or the hotel waste tanks and terminates in the condenser circulating water discharge tunnel, entering the tunnel in the section downstream of the warm water recirculation return. Effluent from the monitor tanks or the hotel waste tanks is moved by two monitor tank pumps or hotel waste pumps and the flow rate is monitored on a recorder. The steam generator blowdown is controlled and monitored and recorded in accordance with the ODCM prior to the overboard header.

The overboard header is equipped with a radiation monitor that interrupts flow if waste activity reaches a predetermined set point.

C. GASEOUS WASTES PROCESSING SYSTEM

Radioactive waste gases are collected, compressed, stored, analyzed, and monitored in the radioactive waste disposal system. Waste gas found to be suitable for discharge in accordance with the requirements set forth in 10 CFR Part 20 are released under controlled conditions to the auxiliary building ventilation system for dilution prior to discharge at the plant stack (see Section 9.10). A radiation monitor in the plant stack (see Section 11.2.3) automatically interrupts the flow of waste gas in the gas discharge header if the activity reaches a predetermined concentration. The calculated annual air dose at any location which could be occupied by individuals in unrestricted areas shall not exceed 10 millirads for gamma radiation, 20 millirads for beta radiation and 15 millirems to any organ for iodine-131, tritium, and other particulates with half-lines greater than eight days as required by 10 CFR Part 50, Appendix I. The methods of dose calculation are defined in the Offsite Dose Calculation Manual.

Additional amounts of radioactive gases may exist in relatively low concentrations in the containment and auxiliary building, where the gases can evolve from unconfined leakage of reactor coolant, and also in the condenser air ejector discharge, the vent from the blowdown flash tank, and turbine building exhaust under conditions when primary to secondary leakage exists coincident with fuel clad defects. The concentrations are too dilute and the volumes of carrier gases too large to permit collection and storage. However, the amounts of radioactivity released in low concentration waste gas will be known and releases will be terminated if the activity reached predetermined limits.

There may be small amounts of radioactive gas in the Radioactive Waste Processing and CARP buildings. The amount of gas will be extremely low and releases will be measured and recorded.

The annual average dispersion factor (x/Q) for gaseous releases used to determine exposures in the unrestricted area is calculated using data obtained from the meteorological program. This program is described in detail in section 2.5. The annual average value of x/Q is specified in the ODCM. A revision of this value, either due to subsequent data or revised criteria, would affect the gaseous release concentration in direct ratio to the change. The ODCM ensures that all releases are within applicable criteria.

Sources of Waste Gas

Radioactive gases, normally present in trace amounts in reactor coolant liquids, collect in the vapor space above the various tanks and components as the liquid becomes depressurized. Hydrogen gas, used for corrosion control in the CVCS enters the coolant in the volume control tank. Nitrogen gas is used to blanket the tanks and components, thereby greatly diluting the hydrogen and radioactive gases. As a tank fills, or a component operates, the gases occupying the vapor space are forced into the vent header (VH), where they are then known as waste gases.

Processing of Waste Gases

Waste gases from all of the sources mentioned above are collected in the vent header. Two waste gas compressors take suction from the vent header, compress the gas, and then deliver it to one of the four gas decay tanks. Normally, when the vent header exceeds 2 psig, one of the two waste gas compressors is started to deliver the gas to a decay tank. The second compressor will be started if the waste gas flow exceeds the capacity of the operating compressor. The compressors will be run as required to reduce the vent header pressure to less than 2.0 psig. The waste gas can be compressed to 100 psig (nominal) in a gas decay tank, and then discharged on a batch basis.

D. SOLID WASTES PROCESSING SYSTEM

The general types of radioactive solid wastes are produced at the station; solidified concentrate and process resins, used waste and process filters, dewatered ion exchange and filtration media, and miscellaneous solid wastes.

Solidified concentrate is placed in containers, stored in the storage area and finally shipped from the plant to an approved disposal area. Spent resin from the filtration/ion exchange system is sluiced to a high integrity container which is dewatered and eventually shipped for disposal. Used filters and waste demineralizers are placed in a shielded container, stored in the cask decontamination area and eventually shipped from the plant. Miscellaneous solid wastes, such as equipment parts and laboratory glassware, are compacted in the waste solids bailer and then stored prior to off-site shipment.

Sources of Solid Waste

a. Radioactive liquid waste is processed either through a filtration/ion exchange system with the processed water being directed to the monitor tanks or processed through the evaporator producing evaporator bottoms, or concentrate. The evaporator bottoms, or concentrates, are discharged from the waste evaporator in the liquid state and are then stored in the concentrate tanks. Concentrate is then pumped into a 55 gallon drum prepacked with cement and absorbent, or a large liner and mixed with cement and binding chemicals to form a solid monolith.

b. Process wastes containing spent resins are obtained from the filtration/ion exchange system, purification ion exchangers, the cation ion exchanger, the decorating ion exchanger, and the spent fuel storage pool demineralizer.

The resins from other sources and their sluice water are collected in the spent resin storage tank. The contents of this tank are mixed and solids are kept in suspension by nitrogen gas sparging. The contents of the tank are forced by pressurized demineralized water into a shielded resin cask after which the contents are dewatered and shipped from the plant. At this point, it is considered to be a solid waste.

c. Used filter baskets originate from the purification filters, the waste filters, and the spent fuel pool cooling system filter. Solids removed from the liquid are retained on the filter elements which form the basket.

d. Miscellaneous solid waste consist of contaminated articles such as equipment parts, laboratory glassware, clothing, gloves, cleaning tools, rags, towels, and plastic covers originating in the controlled access areas of the plant.

System Components

The major components of the solid wastes system of the RWDS are as follows; the referenced tables summarize pertinent data:

a. Spent resin storage tank;
b. Spent resin pump;
c. Waste solids bailer;
d. Mobile Radwaste Processing System/Filtration/Ion Exchanger (FIX).

System Operation

Radioactive Liquid and Spent Resins

The following operation is followed for the processing of liquid and resin.

a. If the filtration/ion exchange system is in operation, the radioactive liquid is transferred from the waste holdup tanks using the waste holdup transfer pumps. The water that has been processed is directed to the monitor tanks to be analyzed and discharged to the Missouri River through the overboard discharge piping. Depleted filtration ion exchange media is sluiced to a high integrity container and then dewatered using vendor supplied system prior to being shipped offsite for disposal.

   If the evaporator is in operation, the concentrates are pumped to a mobile solidification system in the Radioactive Waste Processing Building where the concentrate is mixed with cement and binding chemicals in a disposable liner. By using mixing blades installed inside the liners, the material is mixed to produce a solid billet. The liner is transferred from the processing area to a storage area using a bridge crane. A transfer shield may be used if the radiation field from the liner is excessive.

b. The resin is flushed from the resin storage tank by demineralized water to a shielded resin cask with liner located in the Radioactive Waste Processing Building through shielded piping. The resin is then dewatered/solidified. The liner with resin is placed in the cask which is shipped offsite.

Miscellaneous Solid Waste

Compactable wastes are placed in a drum which is then placed on the waste bailer located in the Radioactive Waste Processing Building. The waste is then hydraulically compressed. This is repeated until the drum is filled with compressed material. The drum is then removed from the bailer, sealed and stored to await off-site removal. Non-compactable waste are placed in large steel boxes for disposal. The activity of this material is normally low and special shielding is not necessary.

The Process Control Program (PCP) is used to verify satisfactory solidification of waste prior to shipment offsite. The PCP calls for examination of at least one representative test specimen from at least every twelfth batch of wet radioactive waste (e.g., evaporator concentrates and provides for followup actions if the specimen falls to verify proper solidification. [11-4] The Radioactive Waste Processing Building is sized to accumulate a number of containers (e.g., liners, drums, high integrity containers) to permit scheduling of off-site shipments.

Complete copies of all the FSARs reviewed are available from the NRC Public Document Room, at 2120 L Street, NW, Lower Level, Washington, DC 20037.

2.6.3 Review of Process Control Programs and Operating Procedures

In addition to the regulations and controlling documents identified and discussed above in Section 2.3, each nuclear power plant also has a Process Control Program (PCP) and supporting technical specifications and procedures (documented in the site's Operations Manual). These documents are "living" documents and are modified to reflect current plant operating conditions and requirements. Although these documents generally reside at the plant, NRC Resident Inspectors and Regional Inspectors have reviewed these documents and routinely assess the effectiveness of these documents during the conductance of NRC inspections of plant activities (i.e., NRC inspectors observe plant operations that are conducted in accordance to plant procedures and if the plant's operations are adequate then so are the procedures).

Due to information collection request (ICR) limitations associated with this project, copies of PCPs and technical specifications/procedures for each of the 12 study facilities could not be requested. One facility (Cooper Nuclear Station), however, had recently provided copies of their PCP and operating procedures to NRC's Regional Inspector and the Regional Inspector was able to provide us with a set for our review.

The purpose of the PCP at Cooper Nuclear Station was to establish the processing conditions necessary to assure that the radioactive liquid and solid wastes were effectively solidified, dewatered, and/or stabilized. The PCP is comprised of the:

- Dewatering Process Control Program (DCDP)
- Solidification Process Control Program (SPCP)
- Vendor Process Control Program (VPCP)

The DCDP utilizes the site's dewatering system to process solid wet waste streams originating from the liquid radioactive waste treatment system or from chemical decontamination resins. The SPCP utilizes the plant's cement solidification system to process solid wet waste from the liquid radioactive waste treatment system, and the VPCP utilizes NRC approved PCP's, stabilization processes and High Integrity Containers (HICs) to process various forms of solid and liquid radioactive wastes. The various PCPs are followed to ensure that the resultant waste form characteristics are acceptable for burial at licensed low-level radioactive waste burial facilities. An example of the level of detail of information provided in the SPCP is presented in Exhibit 9.

As shown by Exhibit 9, the SPCP outlines the processing procedure; however, additional technical details are obtained from the site's Operations Manual, which provides the specific details on the actual methods by which the wastes are processed. Examples of the types of specific procedures contained in the site's Operations Manual include:

- Radiological Protection Procedure 9.RW.2 - "*Condensate Waste Resins, Spent Resins, RWCU Resins, and Waste Sludge Classification and Listing.*" The purpose of this procedure is to provide instructions to determine the classification of condensate cleanup waste resins, spent resins, Reactor Water Clean-up (RWCU) resins, and waste sludge to determine what radionuclides should be listed on the waste manifest.

- Radiological Protection Procedure 9.RW.3 - "*Dry Radioactive Waste Classification and Listing.*" The purpose of this procedure is to provide instructions to determine the classification of dry radioactive waste such as laboratory and counting room solid wastes, rags, building rubble, paper, metal, wood, cardboard, contaminated protective clothing, and air filters. This procedure also provides a method of determining which radionuclides in these wastes must be listed on a waste shipping manifest.

- Radiological Protection Procedure 9.RW.4 - "*Control of On-Site Storage of RWCU and Condensate Resins and Wastes (Transfer into Storage).*" The purpose of this procedure is to provide instructions for the control of low-level radioactive waste (LLRW) stored on-site at the LLRW storage pad, outside the protected area. It also defines the activity limits of the waste, the allowable surface contamination, the packaging requirements for storage in these areas, and the examination, handling, operation, storage, and maintenance of the temporary storage equipment.

- Radiological Protection Procedure 9.RW.5 - "*Control of On-Site Storage of RWCU and Condensate Resins and Waste (Transfer out of Storage).*" The purpose of this procedure is to provide instructions for the movement of low-level radioactive waste (LLRW) in the form of RWCU and condensate resins and other forms of LLRW from storage on the LLRW storage pad.

EXHIBIT 9

Excerpt of SPCP from Cooper Nuclear Station

Section E.1.c - Operation -Specific

"1.8± 0.3 cubic feet of dry Portland Type I cement is added to each DOT 17H specification 55 gallon drum. It has been demonstrated that this volume of cement will properly SOLIDIFY the waste streams processed by the drum mixing system. The waste to be SOLIDIFIED is added in quantities sufficient to fill the drum along with approximately seven gallons of demineralized water. When the drum filling is complete the drum is transferred to the drum mixing station. A representative waste sample from one drum of each batch is taken and analyzed for pH. Experience has conclusively shown that the SOLIDIFICATION process is unaffected by pH as long as the pH of the waste remains within the range of 2 to 13.

The filled drum is mixed by an automatic, sequence controlled, in-drum mixer. During the mixing sequence approximately five gallons of additional demineralized water are added to the filled drum. When the water addition is complete and the final mixing steps are sequencing to completion, the mixer motor amps are checked to ensure sufficient water has been added. Slight changes in the amount of water being added during the mixing sequence may be made to adjust the mixer motor amps to approximately seven amps. These adjustments are made on the first several drums being processed from the waste batch, and are then programmed into the drum mixing sequence for the remaining drums of the batch. Upon completion of the mixing process, and prior to the cement setting, one drum from the batch is sampled in order to determine its isotopic content and distribution. The drum's radiation level is also measured. By comparing this drum's isotopic distribution, concentration, and radiation level with the radiation readings on each of the other drums in the batch, the total concentration of the radionuclides present in each drum can be determined. This data comparison method may also be used to determine waste carry-over from previous batches into the batch currently being processed.

Following a minimum of twenty-four hours after mixing, each SOLIDIFIED drum is visually inspected for freestanding liquid and SOLIDIFICATION. Every tenth drum of the batch is quality control checked for resistance to penetration to verify SOLIDIFICATION. The penetration test verifies that the SOLIDIFIED waste has a minimum compressive strength of 50 psi. Filled drums meeting the freestanding liquid and SOLIDIFICATION criteria are capped and transferred to the drum storage line for later shipment to a licensed burial site. The packaging, classification and shipping of waste processed via the CNS SPCP are in accordance with the applicable sections of 10 CFR 61, 10 CFR 71, and 49 CFR Parts 171 through 178."

- Radiological Protection Procedure 9.RW.5.3.12 - "*Filling Containers with Waste/Radioactive Material.*" The purpose of this procedure is to provide the instructions for filling the various types of dry active waste (DAW) shipping containers and radioactive material (RM) shipping containers used at the site.

- Radiological Protection Procedure 9.RW.6 - "*Control of On-Site Dry Active Waste Storage.*" The purpose of this procedure is to provide instructions for the control of dry active wastes (DAW) stored on-site in the MPF storage area and to define the activity limits of the waste, the allowable surface contamination, the packaging and storage requirements for storage in this area, and the examination, handling, operation, storage, and maintenance of the temporary storage equipment.

- Radiological Protection Procedure 9.RW.8 - "*Inspection of On-Site LLRW Storage.*" The purpose of this procedure is to provide instructions for the quarterly inspection of the low-level radioactive waste (LLRW) containers stored on the LLRW storage facility and MPF storage area.

Copies of the Cooper Nuclear Station's PCP and the Radiological Protection Procedures listed above are provided in Attachment 3. Salem I's "Interim Low-Level Radwaste Transfer and Storage" standard operating procedures (SOP) and its 10 CFR 50.59 submission for their "Low-Level Radwaste Storage Facility" are also presented in Attachment 3.

2.6.4 Review of Systematic Assessment of Licensee Performance Reports

As discussed above in Section 2.5.1, the NRC uses the Systematic Assessment of Licensee Performance (SALP) process to articulate the agency's observations and insights on the licensee's safety performance. During the SALP, NRC Regional Inspectors work with the NRC Resident Inspectors to do a comprehensive examination of the operations at the specific nuclear power plant. The functional area of the SALP titled "Plant Support" is the area in which the inspectors examine waste management activities (including waste treatment and waste storage).

To get a better understanding of the facility's performance of activities associated with occupational radiation safety, radioactive waste management, radiological effluent control and monitoring, transportation of radioactive materials, and housekeeping, NRC SALP reports were obtained for each of the 12 study facilities. The SALP reports were reviewed and relevant findings regarding the facility's performance were extracted. Exhibit 10 summarizes the plant support score and relevant findings by study facility.

As shown above in Exhibit 10, nine of the 12 facilities received a "superior" performance rating in the area of Plant Support, and the remaining three facilities (Edwin I. Hatch 2, Palisades, and Fort Calhoun receive a "good" performance rating. Copies of the reviewed SALP reports are attached as Attachment 4.

2.6.5 Review of NRC Inspection Reports

NRC Regional Inspectors also conduct periodic inspections of the plants's solid radioactive waste management and transportation of radioactive materials program following NRC's Inspection Procedure 86750. During an inspection, the NRC inspectors reviewed the plant's solid radioactive waste program and information was gathered through observation of activities, tours of the radiologically controlled areas, discussions with cognizant personnel, and review and evaluation of procedures and documents.

We therefore contacted the NRC Regional Inspectors to obtain copies of recent inspection reports prepared for each of the study facilities. We reviewed the inspection reports for observations regarding waste management practices and have summarized our findings in Exhibit 11.

EXHIBIT 10

Summary of SALP Ratings by Facility

EXHIBIT 10 (Continued)

Study Group	Date of SALP Report	Date of SALP Coverage	Plant Support Rating	Comments
Watts Bar 1	1/14/98	11/10/96 - 12/6/97	1	Excellent radiological (rad.) controls to protect safety and health of public from radioactive contamination. Rad. effluent control program maintained doses to public to a fraction of regulatory limits. Very effective rad. effluent release monitoring program; negligible impact on environment.
	12/19/96	11/12/95 - 11/9/96	1	Rad. control program performed well in protecting safety and health of public and employees. Effluent control prog. was effective in limiting exposure to public by keeping radionuclide concentration in liquid and gaseous effluents to very low levels. Monitoring program confirmed plant effluent releases were low.
North Anna 1	2/21/97	12/25/94 - 1/11/97	1	Rad. control program was effective at limiting radiation exposure to employees and public. Effluent control program was effective in maintaining radionuclide concentrations in liquid and gaseous effluents at a fraction of regulatory limits. Environmental monitoring prog. confirmed only trace amounts of activity in samples collected around the plant. Participated in EPA sampling cross-check quality assurance program.
	1/31/95	4/4/93 - 12/24/95	1	Plant had excellent contamination control practices. Personnel did not experience excessive radiation in any area of plant. Radioactive levels in effluents to the environment were kept well below regulatory levels.
Fort Calhoun	9/4/97	1/26/96 - 8/2/97	2	Efforts to reduce radioactive effluents releases from plant were effective. Large number of smaller contaminated areas within rad. controlled areas that impacted plant operators. Rad. waste effluent management, rad. environmental monitoring, and solid radioactive waste management practices were all effective.

EXHIBIT 10 (Continued)

Study Group	Date of SALP Report	Date of SALP Coverage	Plant Support Rating	Comments
Callaway	5/13/97	4/30/95 - 5/30/95	1	Liquid and gaseous waste effluent management programs were properly implemented. Transportation of radioactive materials and radioactive waste management program were implemented properly. Problems identified in rad. environmental monitoring program involving location of sampling station and condition of sampling equipment.
Palisades	1/24/97	5/28/95 - 11/23/96	2	Rad. environmental monitoring program performance was very good. Previously identified weaknesses in the Rad. environmental monitoring program were effectively corrected.
	7/3/95	10/31/93 - 5/27/95	2	A weaker performance was noted in the rad. environmental monitoring program. Discovery of 30 contaminated objects found outside of a radiologically controlled area. Environmental monitoring sample collection techniques were deficient. Deficiencies seem to be long standing.
Summer	8/26/98	10/27/96 - 6/25/98	1	Improvements noted in control of contaminated material and reduction in contaminated areas, as compared to previous reviews. Rad. effluent control program was effective in reducing amounts of radioactive material from plant and reducing exposure to public to well below regulatory limits. Decrease in the amount of activity released from plant in liquid and gaseous effluents.
	12/6/96	1/29/95 - 10/26/96	2	Contamination and contaminated material were found outside control boundaries and offsite radiation exposure to members of the public was substantially below regulatory limits. Environmental monitoring program confirmed only trace amounts of contamination were detected around plant; in general an effective program.
	3/17/95	2/28/93 - 1/28/95	1	Rad. effluent program provided superior support to operation of the plant. Effluent releases maintained well below regulatory limits. In general, radioactive waste processing was good with adequate attention to detail during waste shipment preparation.
Indian Point 3	7/2/97	3/2/96 - 5/17/97	1	Continued to implement effective program for radioactive waste management and transportation, waste processing, waste handling, waste storage, effluents control, and environmental monitoring. Environmental monitoring program was effective in ensuring impact on public and environment was minimal.
Salem 1	9/15/98	3/1/97 - 8/1/98	1	The solid radioactive waste transportation program was effectively implemented. Radwaste sampling, processing, and classification activities were properly performed and shipment documentation conformed to regulatory requirements. Contaminated equipment and radwaste storage were effectively controlled and the amount of contaminated equipment and material in storage was kept to a minimum. Radiological effluents were well monitored and controlled, and the programs for radiological environmental monitoring and meteorological monitoring were effectively implemented during this period.

EXHIBIT 10 (Continued)

Study Group	Date of SALP Report	Date of SALP Coverage	Plant Support Rating	Comments
Salem 1	1/3/95	5/20/93 - 11/5/94	1	Continued strong performance in activities involving radioactive waste handling, processing, packaging, storage and transportation, and contamination control. Highly effective effluent and environmental monitoring programs. Completed construction of advanced radioactive waste storage facility. Downward trend noted in amounts of radioactive waste produced. Strong performance in rad. environmental monitoring and effluent control programs and effective program to measure activity in process and effluent samples.
Cooper	8/17/98	1/12/97 - 7/11/98	1	Effective radioactive effluent, solid radioactive waste, and rad. environmental monitoring programs were implemented.
	2/14/97	7/9/95 - 1/11/97	2	Effective radioactive waste management and waste reduction program were implemented
Fermi 2	1/9/98	3/31/96 - 11/7/97	1	Rad. protection programs for the storage, classification, treatment, and transportation of radioactive waste and material were well implemented. Staff accurately assessed offsite dose and environmental data showed no discernable rad. impact.
Hatch 2	4/4/97	5/28/95 - 2/22/97	2	Rad. effluent controls and monitoring were effective, resulting in only very small (fraction of regulatory limit) doses to members and public. Multiple personnel contaminations and contaminated material was found outside of rad. controlled areas. Solid radioactive waste control and transportation programs were effectively implemented.
	7/11/95	11/28/93-5/27/95	2	Radioactive effluents were effectively controlled with projected offsite doses being well within regulatory limits. Radioactive material preparation, packaging, and transporting was properly managed with no transportation incidents during review period. Environmental monitoring program was well run and confirmed low level of effluents from plant.
Peach Bottom 3	7/17/97	8/15/95 - 6/7/97	1	Effective radioactive waste processing, reduction, handling, storage, and transportation programs including effective implementation of revised DOT and NRC radioactive material shipping regulations. Minor discrepancies with UFSAR conformance in the area of radioactive waste processing were noted. Effective effluent controls and environmental monitoring programs were in place. Well run environmental laboratory. Some problems associated with the burning of slightly contaminated oil and release of sewage without an evaluation.
	12/5/95	5/1/94 - 8/14/95	1	Radioactive waste management and shipping programs were well implemented and a number of initiatives were taken to reduce radioactive waste such as incentive-based radioactive waste minimization program. Excellent implementation of radioactive effluent controls program. Efforts to minimize routine liquid releases were also implemented.

Key: 1 = superior performance; 2 = good performance; 3 = acceptable performance

EXHIBIT 11

Summary of Radwaste Observations Noted in NRC Inspection Reports

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
Indian Point 3	3/3/98	12/16/97 - 2/9/98	"Overall, the solid radioactive waste program and the program for the transportation of radioactive materials and related activities were being implemented effectively." To minimize the generation of radioactive waste, a 'green is clean' program was in effect. Also, the collected materials were surveyed prior to release. Potentially contaminated materials were sorted based on their ability to be incinerated or compacted in order to maximize volume reduction and to minimize the final volume of radioactive waste. All of the radioactive material storage facilities/areas were properly secured and posted.
Peach Bottom 3	9/26/94	8/1/94 - 8/5/94	Radioactive waste management program was well implemented. No violation of NRC regulatory requirements were identified. "The facility was designed in accordance with the dose limitations of 10 CFR 20, 40 CFR 190, and NRC Generic Letter 81-38...No inadequacies were noted regarding the licensee's conclusion that storage of low level wastes (mainly spent filter media) in the cell area did not pose an unreviewed safety question. The licensee was completing a revision to the safety review to accommodate planned storage of low level radioactive wastes in the bulk DAW storage area."
	10/4/93	8/2/93 - 8/6/93	"No violations of regulatory requirements were identified. The lack of comprehensive corrective actions for some radiological discrepancies developed under the ROR process was considered a significant radiological controls program weakness."
Salem 1	8/21/98	6/22/98 - 8/1/98	Solid radioactive wastes were effectively sampled, packaged, and dewatered in accordance with requirements; however, the need to update the waste characterization and packaging program to include the filtrate wastes from the tubular ultra-filtration system prior to waste shipment remains. Have effectively limited the amount of stored contaminated equipment and radioactive wastes. Radioactive waste processing and radioactive material shipping procedures were of good quality and effectively implemented regulatory requirements.

EXHIBIT 11 (Continued)

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
Hatch 2	1/23/98	11/16/97 - 12/27/97	Conduct of the operations of the facility was generally characterized by safety conscious operations, sound engineering and maintenance practices, and careful radiological work controls. "Radiological controls, area postings, and container labels associated with radwaste processing, storage, and transportation activities were maintained in accordance with Tss: 10 CFR Parts 20 and 71: and 49 CFR Parts 100-179 requirements. Excluding source check requirement concerns for liquid effluent releases, procedural guidance was adequate and implemented effectively. Radwaste processing, packaging and transportation activities were implemented effectively. Licensee initiatives to manage exposure and reduce worker contamination events during the U1 RFO 17 activities ere effective."
	1/6/97	10/26/96 - 12/7/96	Conduct of the activities at the Hatch facility was generally characterized by safety-conscious operations, sound engineering and maintenance practices, and careful radiological work controls. "A violation, consisting of several examples of failure to adhere to configuration management requirements, was identified." Additionally, the report documents the weakness in the ability to recognize and declare in a timely manner the existence of an emergency. "Radiological controls for high and very high radiation areas were maintained in accordance with TS requirements. Area postings and labels for containers of radioactive material were appropriate. Effluent release documentation and radiological environmental monitoring program results were prepared in accordance with ODCM requirements. The release data and environmental monitoring results verified offsite releases and resultant doses were a small fraction of the allowable limits. Audits for the radwaste and effluent processing programs were thorough and comprehensive."
	3/27/95	2/27/95 - 3/3/95	"Within the scope of the inspection, violations or deviations were not identified." Adequate procedures for storing and labeling radwaste within the RCA were implemented. Additionally, the licensee was actively developing plans for providing additional radwaste storage capacity.

EXHIBIT 11 (Continued)

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
North Anna 1	8/10/98	5/31/98 - 7/11/98	"Conduct of activities was generally characterized by safety-conscious plant operations, good maintenance and engineering practices, and cautious radiological work practices. There was an overall decreasing trend in the collective personnel exposures and the licensee was generally successful in meeting established goals for ALARA. Maximum individual radiation exposures were controlled to levels which were well within the licensee's administrative limits and the regulatory limits for occupational dose specified in 10 CFR 20.1201(a) The licensee had developed and was implementing a comprehensive action plan for reducing personnel exposure from the elevated dose rates in the plant following the Unit 2 refueling outage."
	8/20/97	8/10/97 - 9/20/97	No discrepancies were noted and general RP practices were proper."
	1/6/97	11/2/96 - 12/7/96	"Conduct of activities was generally characterized by safety conscious operations. However, a significant number of deficiencies were identified during engineering-related inspections. The licensee was closely monitoring collective and individual radiation dose exposure, and that the licensee was meeting established ALARA goals and occupational dose limits."
	9/9/96	7/1/96 - 8/10/96	"No concerns with licensee facilities, equipment or analysis were identified during the inspection. The licensee was informed that the absence of the required 10 CFR 20.1904(a) label information on a container of licensed material was a violation."
	4/25/94	3/28/94 - 4/1/94	"No violation or deviations were identified."
Summer	6/2/97	3/23 - 6/3/97	"Facility was generally characterized by safety conscious operations and work practices and conservative decision making involving plant restart. An URI was identified concerning the failure to meet the requirements of 10 CFR 70.24, criticality accident requirements."

EXHIBIT 11 (Continued)

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
Watts Bar 1	4/14/97	2/2/97 - 3/15/97	Violations of NRC requirements occurred."Radiological facility conditions and housekeeping in radioactive waste storage areas were observed to be good, material was labeled appropriately, and areas were properly posted. In addition, RP/ALARA preplanning for the first refueling outage in September 1997 was progressing satisfactorily. Radiation worker internal and external doses were being maintained well below regulatory limits and the licensee was continuing to maintain exposures ALARA. One VIO (failure to administratively control locked high radiation door keys) one URI (training records) and one IFI (review the refueling canal confirmatory shielding measurements) were identified."
	12/2/96	9/28/96 - 11/9/96	"Conduct of activities was generally characterized by good operations, strong radiological controls and emergency preparedness, effective outage maintenance and engineering support, and thorough self assessments. Radiological controls continue to be effective although there was room for improvement in ALARA planning on emergent work. At the time of inspection, radiological housekeeping was observed to be adequate. Licensee had effectively implemented procedures to track the availability of radiation monitors and to demonstrate operability of process and effluent radiation monitors by performance of surveillances at the frequencies specified in the TSs and the ODCM."
	9/4/96	7/1/98 - 8/10/96	Facility generally characterized by safety-conscious operations, sound engineering and maintenance practices, and careful radiological work controls. "Licensee had implemented and maintained an effective program to monitor and control liquid and gaseous radioactive effluents. The projected offsite doses resulting from those effluents were well within the limits specified in the Tss, ODCM, and 40 CFR 190."

EXHIBIT 11 (Continued)

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
Fermi 2	6/25/98	?-6/12/98	The implementation of the solid radwaste program regarding radwaste processing, storage, and shipment continued to be effective. In particular, the dewatering equipment was highly reliable and the OSSF surveillances were comprehensive.
	6/13/97	?-5/16/97	The implementation of the solid radwaste process, storage, and shipping program was successful.
Palisades	4/21/97	2/24-28 & 3/25-27/97	A violation pertaining to the lack of adequate procedural guidance for determining, controlling, and logging the volume of spent resin handled in the solid radioactive waste system was observed. In addition, use of the procedure resulted in the overfilling of a spent resin storage tank, and spent resin subsequently entered the equipment drain system downstream of the storage tank, rendering the equipment drain system unusable from December 1996 to the time of this inspection.
	9/1/97	8/4/97 - 8/8/97	"No violations of NRC regulations were identified." The solid radioactive waste management program was effectively implemented. "Minor error in packaging indicated a lack of attention to detail by plant personnel. Review of the status of solid radioactive waste treatment equipment revealed material condition and housekeeping concerns in the purification filter and demineralizer rooms. The new volume reduction system was effectively utilized to accomplish further radwaste reduction over the previous system. Recent initiatives to reduce dry active waste generation have been successful, and the formation of an inter-departmental team demonstrated a strong commitment to radwaste reduction. Implementation of the solid radwaste storage program was successful. The paraffin-based volume reduction system was effectively utilized to accomplish further radwaste reduction over the previous system. Recent initiatives to reduce radwaste generation have been successful. Plant personnel had surveyed and effected repairs for a variety of radwaste storage and processing components."
Callaway	Unknown	8/3/98 - 8/7/98	"A good solid radioactive waste management program was in place." Housekeeping in the radwaste building was also very good. " A violation of 10 CFR 71.111 was identified because dry active waste was stored within 10 feet of a permanent structure contrary to procedural requirements. The inspector performed an inventory of selected waste containers located in the low level storage area of the radwaste building and noted no problems with the inventory. Containers were properly labeled in accordance with the requirements of 10 CFR 20.1904 and were maintained in good physical condition. "

EXHIBIT 11 (Continued)

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
Cooper	4/17/98	4/6/98 - 4/9/98	Facility had implemented a good solid radioactive waste management program. "Waste stream sampling and analyses met regulatory requirements. The amount of solid radioactive waste generated showed significant reduction from 1993 to 1994. The amount of solid radioactive waste generated between 1994 and 1997 was below the boiling water reactor national average. Good facilities were maintained for the processing, storage, and management of solid radioactive wastes and transportation activities. An effective radioactive waste inventory/accountability system was maintained. Housekeeping in the radioactive waste processing and storage areas was good."
	10/11/96	9/9/96 - 9/13/96	The liquid and gaseous radioactive waste management and solid radioactive waste management programs were properly implemented and satisfactorily performed. "Poor sample handling techniques used during the collection and analysis of a floor drain tank sample and iodine charcoal cartridges from the stations's ventilation systems. The radiochemistry counting facility was equipped with state-of-the art analytical instrumentation to perform the required analyses. The analytical instrumentation was properly maintained, tested, and calibrated."
	9/7/94	8/8/94 - 8/12/94	"No major changes in radwaste facilities, equipment, or procedures. An excellent radioactive waste reduction program was implemented. Radioactive waste was properly classified, characterized, and prepared for shipment. A review of personnel exposures disclosed that internal occupational exposures were insignificant. An excellent radioactive waste reduction program was implemented."

EXHIBIT 11 (Continued)

Study Group	Date of Inspection Report	Date of Inspection Coverage	Radioactive Waste Comments Raised by Inspectors
Fort Calhoun	7/29/98	7/6/98 - 7/10/98	"A violation in the waste stream sampling procedure was identified. This violation resulted in use of information that, because of your recent history of leaking fuel, may no longer allow the facility to accurately predict the isotopic abundances in the dry active waste stream." This could cause improper classification of waste shipments intended for burial. Radiological waste was stored in accordance to commitments. Radwastes are stored according to Sec. 11.1.4 of the FSAR
	5/4/94	4/18/94 - 4/22/94	"A good radioactive waste minimization program was being implemented. Interim storage for radioactive waste was provided in the radwaste building. Good quality assurance audits and surveillances of the solid radioactive waste management were performed by qualified auditors." The interim storage area inside the radwaste building was secured, posted properly, and provided ample interim storage space for more than the amount of radioactive waste that would be generated by the station in 5 years.
	10/7/93	9/20/93 - 9/24/93	"The radioactive waste effluent management program was being properly implemented." Additionally, an excellent liquid and gaseous radioactive waste effluent program was being implemented. "The quantities of radionuclides released in the gaseous radioactive waste effluents were within Offsite Dose Calculation Manual limits."

As shown in Exhibit 11, the solid radioactive waste management programs are being effectively managed and implemented at all of the sites, with two exceptions. First, a recent incident has resulted in the NRC's issuance of a notice of violation for Fort Calhoun Station. Specifically, during the July 1998 inspection, NRC Inspectors noted that:

- "Dry active waste samples were not taken annually. Dry active waste stream samples were collected in June 1995 and August 1997."

- "Off-site laboratory results of the dry active waste stream were not compared with Fort Calhoun gamma isotopic results for the same waste stream sample to verify consistency between the two analyses from August 1995 to July 1998."

- "Annual off-site laboratory waste stream sampling results for the dry active waste stream were not compared with the previous year's results for the same waste stream from August 1995 to July 1998."

- "Scaling factors for the dry active waste stream were not updated from August 1995 to July 1998.

NRC, therefore, has issued a notice of violation that Fort Calhoun has 30 days to state: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved.

The second incident occurred during a March 1997 inspection at Palisades Nuclear Generation Plant. Specifically, due to the lack of adequate procedural guidance for determining, controlling, and logging the volume of spent resin handled in the solid radioactive waste system, the spent resin storage tank was overfilled and spent resin entered the equipment drain system downstream of the storage tank. NRC issued a notice of violation requesting the Palisades plant to respond in 30 days and to state: (1) the reason for the violation, or, if contested, the basis for disputing the violation or severity level, (2) the corrective steps that have been taken and the results achieved, (3) the corrective steps that will be taken to avoid further violations, and (4) the date when full compliance will be achieved. Information regarding Palisades response was not available at this time.

Copies of this inspection report and all the other the inspection reports reviewed to prepare Exhibit 11 are provided in Attachment 5.

3.0 NRC Licensed Facilities (other than reactors)

As discussed in Section 1, NRC also ensures that civilian uses of nuclear materials are carried out with adequate protection of the public health and safety, of the environment, and of national security at the following types of operations:

- *Industrial Facilities* - include pharmaceutical, sealed source, and irradiator manufacturing, biotechnology manufacturing, targeted organ research, fuel storage, waste processing, and fuel fabrication. Industrial facilities use radioactive materials to measure the thickness, density or volume of materials; to determine the age of prehistoric and geological objects; to examine welds and structures for flaws; to analyze for oil and gas exploration; and for various other types of research and development. During research and chemical analysis, test tubes, bottles, tubing, and process equipment come into contact with radioactive material, become contaminated and are classified as low-level waste.

- *Medical/Academic Institutions* - include pilot plants, reactors, and laboratory research. Radioactive materials are used in numerous diagnostic and therapeutic procedures for patients. During these procedures, test tubes, syringes, bottles, tubing and other objects come into contact with radioactive materials. Animal carcasses containing radioactive material also are generated. All of these materials must be handled through decay-in-storage and disposal as either non-radioactive waste or low-level radioactive waste.

- *Government Facilities* - are similar to medical and academic institutions.

All of these operations generate low-level radioactive waste (LLRW) (and low-level mixed waste or LLMW through similar activities, regardless of the generator type. Exhibit 12 provides an overview of facilities generating LLMW, the types of waste generated, and the practices resulting in the generation of the waste.[13] The most predominant waste streams generated across all of the major generating sectors include liquid scintillation cocktails (LSCs), organic chemicals, and lead wastes.

As shown in Exhibit 12, the predominate waste generating practices include lab counting procedures, residues from research and manufacturing/spent reagents, cleaning of laboratory equipment and cleaning of contaminated components, and lead contaminated during processing.

A total of 21,685 licenses have been issued for medical, academic, and industrial uses of nuclear material; 5,961 licenses are administered by the NRC and the remaining 15,724 licenses are administered by the 30 States that participate in the NRC Agreement States Program.[14] (See Section 3.1 below for a discussion regarding Agreement States.)

EXHIBIT 12

---

[13] United States Environmental Protection Agency , *Low-Level Mixed Waste, A RCRA Perspective for NRC Licensees*, EPA/530-SW-90-057, 1990, p. 7.

[14] The State of Massachusetts became an Agreement State in March 1997.

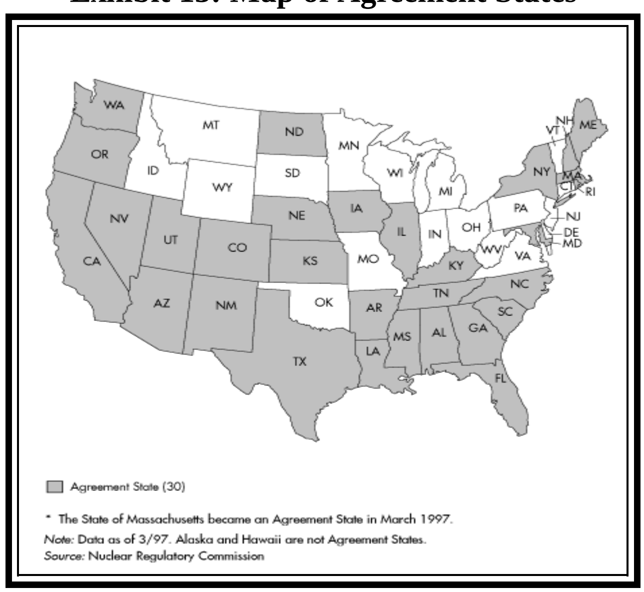
LLMW Generation by Industry/Facility Type

	Industry/Facility Type			
Categories of Hazardous Wastes	**Pharmaceutical Manufacturing**	**Biotechnology Manufacturing**	**Medical/Academic Institutions**	**Other Manufacturing**
Organic solvents of LSCs	X	X	X	X
Organic chemicals	X	X	X	X
Lead wastes	X		X	X
Chlorinated fluorocarbon wastes (CFCs)			X	
Waste oil*			X	X
Phenol/chloroform				X
Waste Generating Practices				
Laboratory counting procedures	X	X	X	X
Residues from research and manufacturing/spent reagents	X	X	X	X
Cleaning of laboratory equipment	X	X	X	X
Cleaning of contaminated components	X		X	X
Contaminated Lead	X	X	X	X
Back flush of resin filters and changeout		X		

* If waste oil meets RCRA characteristics for a hazardous waste or contains listed constituents.

3.1 Agreement States

Exhibit 13: Map of Agreement States



Agreement states are states that have signed agreements with the NRC allowing them to regulate the use of radioactive material within their state. Other states that have applied for the Agreement States Program include Ohio, Pennsylvania and Oklahoma. At this point in time, thirty states have signed agreements with NRC enabling the various "Agreement States" to regulate source, byproduct, and small quantities of special nuclear material within their boundaries. Exhibit 13 presents a map of the Agreement and Non-Agreement States.

Most facilities located in Agreement States are subject to regulatory requirements for radioactive material under state law. This applies to all source, special nuclear, and byproduct material except that from nuclear utilities and fuel cycle facilities, which are subject to NRC's requirements and DOE facilities, which are subject to DOE Orders. While states are required to adopt programs that are comparable with the NRC program, states may also adapt more stringent programs in addition to their comparable Federal NRC program. Exhibit 14 presents a summary of the total number of materials licenses issued by NRC and Agreement States - by state.

EXHIBIT 14

Summary of Licenses by State
(Source: NRC Information Digest: 1997 Edition
NRC Report Number: NUREG-1350, Volume 9)

State	Number of Licenses		State	Number of Licenses	
	NRC	Agreement States		NRC	Agreement States
Alabama	16	401	Montana	84	0
Alaska	52	0	Nebraska	4	171

Arizona 26	285	Nevada	5	181
Arkansas 9	267	New Hampshire	11	99
California 61	2,100	New Jersey	538	0
Colorado 26	388	New Mexico	22	240
Connecticut 212	0	New York	51	1,558
Delaware 68	0	North Carolina	16	538

District of Columbia	5	0	North Dakota	8	69
Florida	24	1,144	Ohio	620	0
Georgia	17	500	Oklahoma	234	0
Hawaii	64	0	Oregon	10	268
Idaho	75	0	Pennsylvania	808	0
Illinois	57	789	Rhode Island	2	83

Indiana	0	South Carolina	12	330
Iowa	215	South Dakota	45	0
Kansas	322	Tennessee	25	563
Kentucky	403	Texas	60	2,043
Louisiana	511	Utah	15	223
Maine	128	Vermont	37	0
Maryland	561	Virginia	38	0

Massachusetts	43	612	Washington	19	412
Michigan	522	0	West Virginia	199	0
Minnesota	172	0	Wisconsin	272	0
Mississippi	10	320	Wyoming	89	0
Missouri	801	0	Others*	161	0
			T	5	1

*"Others" includes territories such as Puerto Rico, Virgin Islands, Guam, and American Samoa.

3.2 Summary of Applicable Regulations

As briefly discussed, material licensees are regulated by the NRC (and if applicable, Agreement State), which has issued numerous performance-based regulations, regulatory guides, generic communications, NUREGs, and other documents. This section discusses the major components of the regulations and other documents that pertain to the storage of radioactive wastes at industrial, medical, research, academic, and government facilities. This discussion also provides the context for how the various regulations and requirements specified in the numerous NRC documents work together to enable the NRC to ensure these facilities are operating in a manner that is safe to both human health and the environment.

3.2.1 NRC Regulations

The Atomic Energy Act of 1954, as amended, authorizes NRC to develop regulations that licensees must follow to protect health and safety. NRC regulations of interest are found at 10 CFR Chapter I -- Nuclear Regulatory Commission; a partial listing of the parts most relevant to the management of radioactive waste by material licensees includes:

10 CFR 20 -	Standards for Protection Against Radiation
10 CFR 30 -	Rules of General Applicability to Licensing of the Possession or Use of Nuclear or Byproduct Material in Medicine, Industry (including Low-Level Waste Management at Power Reactors), Agriculture, or Research
10 CFR 35 -	Medical Use of Byproduct Material
10 CFR 40 -	Domestic Licensing of Nuclear Source Material Facilities
10 CFR 71 -	Licensing of the Packaging and Transportation of Radioactive material

§35.92 Decay-In-Storage

(a) A licensee may hold byproduct material with a physical half-life of less than 65 days for decay-in-storage before disposal in ordinary trash and is exempt from the requirements of §20.2001 of this chapter if it:

(1) Holds byproduct material for decay a minimum of ten half-lives;

(2) Monitors byproduct material at the container surface before disposal as ordinary trash and determines that its radioactivity cannot be distinguished from the background radiation level with a radiation detection survey meter set on its most sensitive scale and with no interposed shielding;

(3) Removes or obliterates all radiation labels; and

(4) Separates and monitors each generator column individually with all radiation shielding removed to ensure that it has decayed to background radiation level before disposal.

(b) A licensee shall retain a record of each disposal permitted under paragraph (a) of this section for three years. The record must include the date of the disposal, the date on which the byproduct material was placed in storage, the radionuclides disposed, the survey instrument used, the background dose rate, the dose rate measured at the surface of each waste container, and the name of the individual who performed the disposal.

In general, the management of low-level radioactive waste is subject to a broad range of regulatory provisions. Licensees are required by NRC's general radiation protection standards (10 CFR Part 20) to ensure that radioactivity levels released to the environment are as low as reasonably achievable (ALARA).[15] Portions of 10 CFR Part 20 (Subpart K) also pertain to waste disposal, which is allowed by the NRC only by (1) transfer to an authorized recipient; (2) decay in storage; or (3) release in effluents, but only if within specified dose limits. Authorized recipients of waste, in turn, must be specifically licensed for one or more of the following waste management alternatives:

[15] Waste management is also subject to standards set by EPA under 40 CFR Part 190.

- Treatment prior to disposal;
- Treatment or disposal by incineration;
- Decay in storage;
- Disposal at a land disposal facility licensed under 10 CFR Part 61; or
- Disposal at a geologic depository licensed under 10 CFR Part 60.

Lastly, the disposal and transportation of radioactive wastes are covered in 10 CFR 61 and 71, respectively. A summary of the relevant NRC regulations is provided below in Exhibit 15.

3.2.2 Regulatory Guides

Specific Regulatory Guides of interest include:

- **Regulatory Guide 8.18** - "*Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable,*" Revision 1, October, 1982.

  NRC prepared this guide especially for medical licensees and recommends methods acceptable to the NRC for maintaining occupational exposures as low as is reasonably achievable (ALARA) in medical institutions. This guide also discusses the functions and qualifications of the radiation safety office and personnel, including the Radiation Safety Officer.[16] Lastly, the guide also discusses the need for adequate storage space locations, equipment, and shielding, including the use of a specially shielded waste receptacle for used syringes and other radioactive wastes in the nuclear medicine laboratory.

---

[16] The title "Radiation Safety Officer," used by many medical licensees, is used to designate the qualified individual who is responsible for carrying out the institution's radiation safety program and who is listed as the Radiation Safety Officer on the institution's "Application for Materials License - Medical."

EXHIBIT 15

Summary of Relevant NRC Regulations for Material Licensees

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
	General Requirements	
19.12	Workers should be kept informed of the storage, transfer, or use of radiation and/or of radioactive material. Instructed in the health protection problems associated with exposure to radiation and/or radioactive material, in precautions or procedures to minimize exposure, and in the purposes and functions of protective devices employed.	Training
20.1101(b)	The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).	Secondary Containment, Detection, Monitoring
20.1302	The licensee shall make or cause to be made, as appropriate, surveys of radiation levels in unrestricted and controlled areas and radioactive materials in effluents released to unrestricted and controlled areas to demonstrate compliance with the dose limits for individual members of the public.	Inspection, Monitoring
20.1406	Applicants for licenses, other than renewals, after August 20,1997, shall describe in the application how facility design and procedures for operation will minimize, to the extent practicable, contamination of the facility and the environment, facilitate eventual decommissioning, and minimize, to the extent practicable, the generation of radioactive waste.	Contamination
20.1801	The licensee shall secure from unauthorized removal or access licensed materials that are stored in controlled or unrestricted areas.	Security, Storage
20.1502	Each licensee shall monitor occupational exposure to radiation and shall supply and require the use of individual monitoring devices.	Monitoring
20.1802	The licensee shall control and maintain constant surveillance of licensed material that is in a controlled or unrestricted area and that is not in storage.	Security, Storage
20.1206	Each licensee shall maintain records of doses received by all individuals for whom monitoring was required, and records of doses received during planned special exposures, accidents, and emergency conditions.	Monitoring
20.2202	Immediate notification. Each licensee shall immediately report any event involving byproduct, source, or special nuclear material possessed by the licensee the may have caused or threatens to cause any harm.	Contamination, Emergency Reporting

EXHIBIT 15 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
20.2203	Corrective steps taken or planned to ensure against a recurrence, including the schedule for achieving conformance with applicable limits, ALARA constraints, generally applicable environmental standards, and associated license conditions.	Corrective Action
20 Appendix G	A waste generator, collector, or processor who transports, or offers for transportation, low-level radioactive waste intended for ultimate disposal at a licensed low-level radioactive waste land disposal facility must prepare a Manifest reflecting information requested on applicable NRC forms 540 and 541, and if necessary, on an applicable NRC form 542. NRC forms 540 and 540A must be completed and must physically accompany the pertinent low-level waste shipment.	Packaging, Shipment
	Byproduct Material Requirements	
30.32	Training. A brief description of the frequency, performance objectives and plans for the training that the licensee will provide workers on how to respond to an emergency.	Training
30.33	The applicant is qualified by training and experience to use the material for the purpose requested in such manner as to protect health and minimize danger to life or property.	Training
30.34	Require such reports and the keeping of such records, and to provide for such inspections of activities under the license as may be necessary or appropriate to effectuate the purposes of the Act and regulations.	Records Management
30.35	Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site. These records may be limited to instances when contamination remains after any cleanup procedures or when there is reasonable likelihood that contaminants may have spread to inaccessible areas as in the case of possible seepage into porous materials such as concrete.	Contamination, Record Keeping
30.52	Each licensee shall afford to the Commission at all reasonable times opportunity to inspect byproduct material and the premises and facilities wherein byproduct material is used or stored.	Inspection, Storage
Radiography and Radiation Safety Requirements for Radiographic Operators		
34.21	The maximum exposure rate limits for storage containers and source changers are 2 millisieverts per hour at any exterior surface, and 0.1 millisieverts per hour at 1 meter from any exterior surface with the sealed source in the shielded position.	Storage, Containers, Exposure Limits
34.23	Each radiographic exposure device must have a lock or outer locked container designed to prevent unauthorized or accidental removal of the sealed source from its shielded position.	Containers

EXHIBIT 15 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
34.31	The licensee shall perform visual and operability checks on survey meters, radiographic exposure devices, transport and storage containers, associated equipment and source changers before use on each day the equipment is to be used to ensure that the equipment is in good working condition, that the sources are adequately shielded, and that required labeling is present.	Inspection, Storage, Containers
34.35	The licensee may not use a source changer or a container to store licensed material unless the source changer or the storage container has securely attached to it a durable, legible, and clearly visible label bearing the standard trefoil radiation caution symbol conventional colors.	Storage, Containers, Labeling
34.73	Each licensee shall maintain records specified in 34.31 of equipment problems found in daily checks and quarterly inspections of radiographic exposure devices, transport and storage containers, associated equipment, source changers, and survey instruments; and retain each record for 3 years after it is made.	Inspection, Storage, Containers, Records Management
	Medical Use of Byproduct Material Requirements	
35.2	Each licensee shall develop and implement a written radiation protection program that includes provisions for keeping doses ALARA.	ALARA Procedures
35.21	A licensee shall appoint a Radiation Safety Officer responsible for implementing the radiation safety program. The licensee, through the Radiation Safety Officer, shall ensure that radiation safety activities are being performed in accordance with approved procedures and regulatory requirements in the daily operation of the licensee's byproduct material program	Security
35.22	Each medical institution licensee shall establish a Radiation Safety Committee to oversee the use of byproduct material.	Security
35.25	A licensee that permits the receipt, possession, use, or transfer of byproduct material by an individual under the supervision of an authorized user as allowed by 35.11 of this part shall: Instruct the supervised individual in the principles of radiation safety appropriate to that individual's use of byproduct material.	Security, Training
35.9	Storage of volatiles and gases. A licensee shall store volatile radio-pharmaceuticals and radioactive gases in the shipper's radiation shield and container. A licensee may store a multi-dose container in a fume hood after drawing the first dosage from it.	Storage, Containers

EXHIBIT 15 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
35.92	Licensee may hold byproduct material with a physical half-life of less than 65 days for decay-in-storage before disposal in ordinary trash and is exempt from the requirements of §20.2001 of this chapter if it (1) holds byproduct material for decay a minimum of ten half-lives; (2) monitors at the container surface before disposal as ordinary trash and determines that its radioactivity cannot be distinguished from the background radiation; (3) removes or obliterates all radiation labels; and (4) separates and monitors each generator column individually with all radiation shielding removed to ensure that it has decayed to background radiation level before disposal.	Storage, Treatment
	Source Material Requirements	
40.26	The documentation of daily inspections of tailings or waste retention systems and the immediate notification of the appropriate NRC regional office of any failure in tailings or waste retention system that results in a release of tailings or waste into unrestricted areas.	Inspection, Reporting
40.36	Records of spills or other unusual occurrences involving the spread of contamination in and around the facility, equipment, or site.	Contamination, Record Keeping
40.62	Each licensee shall afford to the Commission at all reasonable times the opportunity to inspect source or byproduct material and the premises and facilities wherein source or byproduct material is used or stored.	Storage, Inspection
40.65	Effluent monitoring reporting requirements.	Monitoring
	Packaging Requirements	
71.43	General standards for all packages. (1) The smallest overall dimension of a package may not be <10 cm. (2) The outside of a package must incorporate a feature, such as a seal, that is not readily breakable and that, while intact, would be evidence that the package has not been opened by unauthorized persons. (3) Package must include a containment system securely closed by a positive fastening device that cannot be opened unintentionally or by a pressure that may arise within the package.	Packaging, Storage. Containment

EXHIBIT 15 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
71.43	A package must be made of materials and construction that assure that there will be no significant chemical, galvanic, or other reaction among the packaging components, among package contents, or between the packaging components and the package contents, including possible reaction resulting from leakage of water, to the maximum credible extent. Account must be taken of the behavior of materials under irradiation	Packaging, Storage
71.43	A package valve or other device, the failure of which would allow radioactive contents to escape, must be protected against unauthorized operation and, except for a pressure relief device, must be provided with an enclosure to retain any leakage.	Packaging, Containment
71.43	A package must be designed, constructed, and prepared for shipment so that under tests there would be no loss or dispersal of radioactive contents, no significant increase in external surface radiation levels, and no substantial reduction in the effectiveness of the packaging.	Packaging, Storage, Containment
71.43	A package may not incorporate a feature intended to allow continuous venting during transport.	Packaging, Containment, Storage
71.45	Any lifting attachment that is a structural part of a package must be designed with a minimum safety factor of three against yielding when used to lift the package in the intended manner, and it must be designed so that failure of any lifting device under excessive load would not impair the ability of the package to meet other requirements of this subpart.	Packaging, Containment
71.73	Test procedures. Evaluation for hypothetical accident conditions is to be based on sequential application of the tests specified in this section, in the order indicated, to determine their cumulative effect on a package or array of packages.	Packaging, Containers, Inspection, Testing
71.107	The licensee shall establish measures to assure that applicable regulatory requirements and the package design, as specified in the license for those materials and components to which this section applies, are correctly translated into specifications, drawings, procedures, and instructions.	Packaging, Containers, Records Management
71.121	The licensee shall establish and execute a program for inspection of activities affecting quality by or for the organization performing the activity, to verify conformance with the documented instructions, procedures, and drawings for accomplishing the activity.	Packaging, Containers, Inspection
71.125	The licensee shall establish measures to assure that tools, gauges, instruments, and other measuring and testing devices used in activities affecting quality are properly controlled, calibrated, and adjusted at specified times to maintain accuracy within necessary limits.	Packaging, Containers, Maintenance Procedures

EXHIBIT 15 (Continued)

	SUMMARY OF NRC REQUIREMENTS FOR STORAGE OF RADIOACTIVE MATERIALS AND WASTE	
CITATION	***NRC REQUIREMENTS***	***KEYWORDS***
71.127	The licensee shall establish measures to control, in accordance with instructions, the handling, storage, shipping, cleaning, and preservation of materials and equipment to be used in packaging to prevent damage or deterioration.	Packaging, Storage, and Shipping Procedures
71.129	The licensee shall establish measures to indicate, by the use of markings such as stamps, tags, labels, routing cards, or other suitable means, the status of inspections and tests performed upon individual items of the packaging.	Packaging, Container, Labeling
71.133	The licensee shall establish measures to assure that conditions adverse to quality, such as deficiencies, deviations, defective material and equipment, and nonconformance, are promptly identified and corrected.	Packaging, Corrective Action, Conditions Adverse to Quality
71.137	The licensee shall carry out a comprehensive system of planned and periodic audits, to verify compliance with all aspects of the quality assurance program, and to determine the effectiveness of the program.	Audits, Quality Assurance Program

- **Regulatory Guide 10.2 -** "*Guidance to Academic Institutions Applying for Specific Byproduct Material Licenses of Limited Scope,*" Revision 1, December, 1976.

  NRC prepared this guide to describe the type of information that should be submitted in the applications for specific licenses of limited scope for the possession and use by academic institutions of byproduct material. It includes the general principles that will be considered in evaluating an applicant's proposed radiation safety measures. It requests the applicant to describe:

  -- the training and education of the radiation protection officer

  -- the facilities and equipment (e.g., remote handling equipment, storage containers, shielding, and fume hoods) to be made available at each location where radioactive materials will be used

  -- the area(s) assigned for the receipt, storage, preparation, and measurement of radioactive materials

  – requirements for storage of materials and labeling of containers, how areas will be identified where radioactive materials are used, and where and how contaminated articles and glassware are to be handled and stored

- waste disposal procedures to follow in the laboratory, including limitations for disposal of liquid or solid wastes by the user and procedures to use for waste storage within each laboratory.

- **Regulatory Guide 10.4** - "*Guide for the Preparation of Applications for Licenses to Process Source Material,*" Revision 2, December, 1987.

  NRC prepared this guide to provide assistance to applicants and licensees in preparing applications for new licenses, license amendments, and license renewals for the use of source material in such activities as research and development, the use of source materials as shielding, manufacturing depleted uranium and thorium-magnesium alloy products, manufacturing glass containing uranium, manufacturing and distributing other products containing source material, or shaping, grinding, and polishing lenses containing thorium. It requests the applicant to provide the same types of information requested in Regulatory Guide 10.2 and also asks the applicant to describe provisions for monitoring and segregating waste materials (radioactive from nonradioactive and liquid from solid waste).

- **Regulatory Guide 10.5** - "*Applications for Type A Licenses of Broad Scope,*" Revision 1, December, 1980.

  NRC prepared this guide to describe the type of information that should be submitted in the applications for specific licenses of broad scope for the possession and use by academic institutions having an extensive byproduct material management program. This license is the most comprehensive issued and may be written to cover a wide range of radionuclides (e.g., all radionuclides with atomic numbers 1 through 83) for use under the control of a radiation safety committee. It includes the general principles that will be considered in evaluating an applicant's proposed radiation safety measures. In addition to requesting the same type of information cited in Regulatory Guide 10.2, it requests the applicant to describe:

  - facilities and equipment (buildings, hood ventilation and filtering systems, general air and stack monitoring systems, remote handling equipment), and access control methods used in association with the handling and storage of byproduct material

  - for each category of use, the minium physical plant requirements, such as fume hoods, glove boxes, waste receptacles, special sinks, ventilation and containment systems, effluent filter systems, and sketch of each area (i.e., site, building, laboratory room) where hazardous materials are used and stored or where hazardous operations are performed (e.g., centralized radioisotope laboratory used for iodinations or bulk waste storage)

  - procedures for disposing of byproduct material waste; maintenance of current set of requirements (license) placed on the waste burial firm by the Agreement State of Nevada, South Carolina, or Washington before packaging low-level waste material for transfer and shipment to the

Agreement State licensee, and if a waste collection contractor is used, obtain the appropriate requirements from the contractor

– procedures for maintaining current sets of DOT and NRC regulations concerning transfer, packaging, and transport of low-level radioactive waste material

– providing management-approved, detailed operating procedures to all personnel involved in the transfer, packaging, and transport of low-level radioactive waste.

– maintaining inventories of all radioisotopes at the institution and limiting the quantity of radionuclides at the institution to the amounts authorized by the license

3.2.3 Generic Communications

Generic communications of interest include:

- **Generic Letter 85-14**, "*Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility*," August 1, 1985.

  See Section 2.3.3.

- **Information Notice No. 89-13**, "*Alternative Waste Management Procedures in Case of Denial of Access to Low-Level Waste Disposal Sites*."

  The purpose of this notice was to inform addressees of potential restrictions on disposal of low-level radioactive waste, and to suggest actions to minimize possible adverse consequences of these events if licensed activities involve the need to dispose of radioactive waste.

- **Information Notice No. 90-09**, "*Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Material Licensees*," and Attachment, "*Information Needed in an Amendment Request to Authorize Extended Interim Storage of Low-Level Radioactive Waste*," February 5, 1990.

  The purpose of this information notice was to provide guidance to materials licensees on information needed in license amendment requests to authorize extended interim storage of low-level radioactive waste (LLW) at licensed operations. The NRC stated that the following considerations were central to extended storage:

  1. Storage is not a substitute for disposal. Other than storage for radioactive decay, LLW should be stored only when disposal capacity is unavailable and for no longer than is necessary. Licensee planning should consider a specific date by which storage will end and disposal of the LLW will take place.

2. In general, waste should be processed before storage, packaged in a form ready for transport and disposal at the end of the storage period, and clearly labeled in accordance with 10 CFR Subsection 20.203(f) and Section 20.311. Adequacy of the waste form or package may have to be reassessed before disposal.

3. To ensure integrity of packaging and maintenance of waste form, stored waste should be shielded from the elements and from extremes of temperature and humidity.

4. Waste should be stored in an area which allows for ready visual (direct or remote) inspection on a routine basis. Licensees should plan to conduct and document such inspections at least quarterly.

5. Depending on the specific waste involved, licensees may need to have procedures and equipment in place or readily available to repackage the waste, should the need arise.

6. Decomposition and chemical reaction of incompatible waste materials over time can result in gas generation or other reaction products. Licensees should evaluate what they are planning to store and use measures to prevent these reactions. Further, licensees should determine if the need exists for additional ventilation or fire protection/suppression systems.

7. For most waste forms, storage of waste in containers suitable for disposal will not represent a significant increment of direct radiation exposure potential to workers. However, licensees should consider their specific waste and storage plans and determine if additional shielding or other actions are warranted to keep exposures as low as is reasonably achievable (ALARA).

8. Stored waste should be located in a restricted area and secured (e.g., in a locked room) against unauthorized removal for the term of storage.

NRC stated that in the interest of public health and safety, as well as maintaining exposures ALARA, the length of time LLW is placed in storage should be kept to a minimum. Accordingly, NRC's approval of requests by materials and fuel cycle licensees for interim extended storage will generally be for a period of time no greater than five years. Specific information needs relating to storage of LLW are presented in Exhibit 16.

EXHIBIT 16 - Excerpt of Information Needs in Information Notice 90-09

3. Physical Description of Storage Area

   a. Identify the location and provide a diagram of the LLW storage area which demonstrates where packages will be stored and how packages will be accessible for inspection purposes. Include the locations of waste processing equipment (if applicable), air sampling stations, effluent filters and any sources of flammable or explosive material.

   b. Specify the maximum volume of LLW that can be stored in the proposed waste storage area and relate this to annual volume of waste generated.

   c. Specify the type of building/structure in which the waste will be stored and demonstrate that the waste will be protected from weather at all times.

   d. Describe the measures to control access to the LLW storage area and thereby ensure security of the waste.

   e. Describe the ventilation system and how it will assure adequate ventilation of the storage area.

   f. Describe the fire protection and suppression system to minimize the likelihood and extent of fire.

   g. Describe how the adverse effects of extremes of temperature and humidity on waste and waste containers will be avoided.

   h. Describe vulnerability to other hazards such as tornado, hurricane, flood, industrial accident, etc.

4. Packaging and Container Integrity

   a. Describe the packages or containers to be used for storage of LLW, any hazards the waste may pose to their integrity, and the projected storage life of the packages or containers.

   b. Describe your program for periodic inspections of LLW packages to ensure that they retain their integrity and containment of LLW.

   c. Describe your program and equipment (if applicable) for remote handling and/or repackaging damaged or leaking waste containers.

5. Radiation Protection

   a. Describe your program for safe placement and inspection of waste in storage and maintaining occupational exposures as low as is reasonably achievable (ALARA). This program should include periodic radiation and contamination surveys of individual packages and the storage area in general, as well as posting the storage area in accordance with 10 CFR Section 20.203.

   b. Describe projected exposure rates, needs for shielding (if any) and any changes in personnel monitoring which will be required as a result of waste storage.

   c. Describe your procedures for responding to emergencies, including notification of and coordination with local fire, police and medical departments.

   d. Describe your system for maintaining accurate records of waste in storage (including any waste receipts or transfers from or to other licensees) to assure accountability.

- **Policy and Guidance Directive 94-05**, "*Updated Guidance on Decay-In-Storage,*" October 19, 1994.

  The purpose of this policy and guidance directive was to explain that the Division of Waste Management (DWM) was conducting a generic assessment to determine the survey and activity criteria necessary to dispose of radioactive material by decay-in-storage (DIS) pursuant to 10 CFR 2001(a)(2), and that until the generic assessment was completed, NRC regions could routinely grant new or renewal requests for DIS authorizations which met the requirements of 10 CFR 35.92 (a)(1), (a)(2), (a)(3), (a)(4), and (b). NRC noted that although DWM previously concluded that materials with half-lives of 120 days are appropriate for DIS after a minium of 10 half-lives of 120 days, if appropriate surveys were conducted to establish that residual activity is indistinguishable from background, that authorizations for DIS could be granted by the regions for isotopes with half-lives of less than or equal to 120 days without NMSS review pending completion of the assessment.

3.2.4 NRC Reports

Specific NUREG documents of interest include:

- **NUREG-SR1556, V1**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about Portable Gauge Licenses*"

  The purpose of this document is to explain the information requested (or contents) in the license application for material licenses for portable gauges. It also explains the need for a qualified Radiation Safety Program and Radiation Safety Officer, and discussed how licensed materials must be disposed of in accordance with NRC requirements by transfer to an authorized recipient.

- **NUREG-SR1556, V2**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about Industrial Radiography Licenses*"

  The purpose of this document is to explain the information requested (or contents) in the license application for material licenses for radiography. It also explains the need for a qualified Radiation Safety Program and Radiation Safety Officer, and discussed how licensed materials must be disposed of in accordance with NRC requirements by transfer to an authorized recipient.

- **NUREG-SR1556, V6**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about 10 CFR Part 36 Irradiator Licenses*"

  The purpose of this document is to explain the information requested (or contents) in the license application for material licenses for irradiators. It also explains the need for a qualified Radiation Safety Program and Radiation Safety Officer, and discussed how licensed materials must be disposed of in accordance with NRC requirements by transfer to an authorized recipient.

- **NUREG-SR1556, V7**, "*Consolidated Guidance About Material Licenses: Program-Specific Guidance about Academic, Research and Development, and other Licenses of Limited Scope*"

  The purpose of this document is to explain the information requested (or contents) in the license application for material licenses for academic, research and development, and other licenses of limited scope. It explained the need for a qualified Radiation Safety Program and Radiation Safety Officer, and discussed how they must manage radioactive waste generated at their facilities by one or more of the following methods:

  - Decay-in-storage (DIS)
  - Release into sanitary sewerage
  - Transfer to an authorized recipient
  - Extended interim storage
  - Disposal of waste as if it were not radioactive (specific wastes)
  - Obtaining prior approval of NRC of any alternate method
  - Release in effluents to unrestricted areas, other than into sanitary sewerage
  - Incineration.

  Exhibit 17 presents an excerpt from the guidance document discussing waste management at ARDL licensees.

Other (non-NUREG) documents include the following inspection manuals which are used by inspectors at material licensees include:

- **Inspection Procedure 84850**, *"Radioactive Waste Management - Inspection of Waste Generator Requirements of 10 CFR Part 20 and 10 CFR Part 61."* The purpose of this inspection procedure is to enable the inspector to determine whether the licensee has established and is maintaining adequate management-controlled procedures and quality assurance that reasonably ensure compliance with the requirements of 10 CFR Part 20 and 10 CFR Part 61 applicable to low-level radioactive waste (radwaste) form, classification, stabilization, and shipment manifests/tracking. (See Section 2.3.4.)

- **Inspection Procedure 84900**, *"Low-Level Radioactive Waste Storage"*. The purpose of this inspection procedure is to enable the inspector to determine whether fuel cycle and materials licensees who store low-level radioactive waste (LLW) are doing so safely and in accordance with license conditions. This procedure may be applied to any licensee who stores LLW, regardless of when the storage facility was established. The requirements of this procedure are separate from and in addition to those of Inspection Procedure 84850, which addresses the establishment and maintenance of procedures and quality assurance with respect to the waste form, classification, stabilization and manifest requirements of 10 CFR Part 20 and 10 CFR Part 61. (See Section 2.3.4.)

EXHIBIT 17

Item 11: Waste Management at ARDL Licensees

All radioactive waste must be stored in appropriate containers until its disposal and the integrity of the waste containers must be assured. Radioactive waste containers must be appropriately labeled. All radioactive waste must be secured against unauthorized access or removal. NRC requires academic, research and development, and laboratory (ARDL) licensees to manage radioactive waste generated at their facilities by one or more of the following methods:

- Decay-in-storage (DIS)
- Release into sanitary sewerage
- Transfer to an authorized recipient
- Extended interim storage
- Disposal of waste as if it were not radioactive (specific wastes)
- Obtaining prior approval of NRC of any alternate method
- Release in effluents to unrestricted areas, other than into sanitary sewerage
- Incineration.

Licensees may chose any one or more of these methods to dispose of their radioactive waste. It has been NRC's experience that most of the ARDL facilities store or dispose of radioactive waste by a combination of the first four methods, because of the types and amounts of licensed materials used by these facilities.

Applicants should describe their program for management and disposal of radioactive waste. The program should include procedures for handling of waste, safe and secure storage, characterization, minimization, and disposal of radioactive waste. Appropriate training should be provided to waste handlers. Regulations require that licensees maintain all appropriate records of disposal of radioactive waste.

Disposal By Decay-in-storage (DIS)

NRC has concluded that materials with half-lives of less than or equal to 120 days are appropriate for DIS. The minimum holding period for decay is ten half-lives of the longest-lived radioisotope in the waste. Such waste may be disposed of as ordinary trash if radiation surveys (performed in a low background area and without any interposed shielding) of the waste at the end of the holding period indicate that radiation levels are indistinguishable from background. All radiation labels must be defaced or removed from containers and packages prior to disposal as ordinary trash. If the decayed waste is compacted, all labels that are visible in the compacted mass must also be defaced or removed.

Applicants should assure that adequate space and facilities are available for the storage of such waste. Licensees can minimize the need for storage space, if the waste is segregated according to physical half-life. Waste containing radioisotopes of physical half-lives within a certain range may be stored in one container and allowed to decay for at least ten half-lives of the longest-lived radioisotope in the container. Procedures for management of such waste should include methods of segregation, surveys prior to disposal, and maintenance of records of disposal. Records should include the date when the waste was put in storage for decay, date when ten half-lives of the longest-lived radioisotope have transpired, date of disposal, and results of final survey before disposal as ordinary trash. Additionally, a model procedure for disposal of radioactive waste by DIS, which incorporates the above guidelines, is provided in Appendix T.

Release Into Sanitary Sewerage

10 CFR 20.2003 authorizes disposal of radioactive waste by release into sanitary sewerage if each of the following conditions is met:

- Material is readily soluble (or is easily dispersible biological material) in water

- Quantity of licensed material that the licensee releases into the sewer each month averaged over the monthly volume of water released into the sewer does not exceed the concentration specified in 10 CFR Part 20, Appendix B, Table 3

- If more than one radioisotope is released, the sum of the ratios of the average monthly discharge of a radioisotope to the corresponding limit in 10 CFR Part 20, Appendix B, Table 3 cannot exceed unity

- Total quantity of licensed material released into the sanitary sewerage system in a year does not exceed 185 GBq (5 Ci) of H-3, 37 GBq (1 Ci) of C-14, and 37 GBq (1 Ci) of all other radioisotopes combined.

Licensees are responsible to demonstrate that licensed materials discharged into the sewerage system are indeed readily dispersible in water. NRC IN 94-07, "Solubility Criteria for Liquid Effluent Releases to Sanitary Sewerage Under the Revised 10 CFR 20," dated January 1994, provides the criteria for evaluating solubility of liquid waste. Liquid scintillation media and ash are examples of material that may or may not be "readily dispersible."

Careful consideration should be given to the possibility of reconcentration of radioisotopes that are released into the sewer. NRC alerted licensees to the potentially significant problem of reconcentration of radionuclides released to sanitary sewerage systems in IN 84-94, "Reconcentration of Radionuclides Involving Discharges into Sanitary Sewerage Systems Permitted Under 10 CFR 20.203 (now 10 CFR 20.2003)," dated December 1984.

Applicants should provide procedures that will ensure that all releases of radioactive waste into the sanitary sewerage meet the criteria stated in 10 CFR 20.2003 and do not exceed the monthly and annual limits specified in regulations. Licensees are required to maintain accurate records of all releases of licensed material into the sanitary sewerage. A model program for disposal of radioactive waste via sanitary sewer is described in Appendix T.

Transfer to an Authorized Recipient

Licensees may transfer radioactive waste to an authorized recipient for disposal. It is the licensee's responsibility to verify that the intended recipient is authorized to receive the radioactive waste prior to making any shipment. Almost all radioactive waste generated at ARDL facilities consists of low specific activity (LSA) material. The waste must be packaged in approved containers for shipment, and each container must identify the radioisotopes and the amounts contained in the waste. Additionally, packages must comply with the requirements of the particular burial site's license and state requirements. Each shipment must comply with all applicable NRC and DOT requirements. In some cases, the waste handling contractor may provide guidance to the licensee for packaging and transportation requirements; however, the licensee is ultimately responsible for ensuring compliance with all applicable regulatory requirements.

The shipper must provide all information required in NRCs Uniform Low-Level Radioactive Waste Manifest, and transfer this recorded manifest information to the intended recipient in accordance with 10 CFR Part 20, Appendix G. Each shipment manifest must include a certification by the waste generator, as specified in Section II of the appendix. Each person involved in the transfer for disposal and disposal of waste, including waste generator, waste collector, waste processor, and disposal facility operator, must comply with requirements specified in Section III of Appendix G.

Licensees should implement procedures to reduce the volume of radioactive waste for final disposal in an authorized low-level radioactive waste (LLW) disposal facility. These procedures include volume reduction by segregating, consolidating, compacting, or allowing certain waste to decay in storage. Waste compaction or other treatments can reduce the volume of radioactive waste, but such processes may pose additional radiological hazards (e.g., airborne radioactivity) to workers and members of the public. The program should include adequate safety procedures to protect workers, members of the public, and the environment.

Applicants may also request alternate methods for the disposal of radioactive waste generated at their facilities. Such requests must describe the waste containing licensed material, including the physical and chemical properties that may be important to assess risks associated with the waste, and the proposed manner and conditions of waste disposal. Additionally, the applicant must submit its analysis and evaluation of pertinent information on the nature of the environment, nature and location of other affected facilities, and procedures to ensure that radiation doses are maintained ALARA and within regulatory limits.

EXHIBIT 17 (Continued)

Disposal of Specific Waste As If It Were Not Radioactive

The following radioactive wastes may be disposed of as non-radioactive waste:

- Liquid scintillation media (including vials and other items contaminated with liquid scintillation media) containing no more than 1.85 kBq (0.05 mCi) of H-3 or C-14 per gram of the medium; and

- Animal carcasses or animal tissue containing no more than 1.85 kBq (0.05 mCi) of H-3 or C-14 per gram averaged over the weight of the entire animal.

Applicants should have procedures that will ensure that the above limits are not exceeded and that the disposal of animal tissue or carcasses containing licensed material is in a manner that will not permit their use either as food for humans or animals. Applicants must maintain accurate records of these disposals.

Extended Interim Storage

Licensees should exhaust all possible alternatives for disposal of radioactive waste and rely upon on-site extended interim storage of radioactive waste only as a last resort. The protection of workers and the public is enhanced by disposal rather than storage of waste. Licensees may also find it more economical to dispose of radioactive waste than to store it on-site because as the available capacity decreases, the cost of disposal of radioactive waste may continue to increase. Other than DIS, LLW should be stored only when disposal capacity is unavailable and for no longer than is necessary. See NRC IN 90-09, "Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Materials Licensees," for additional information.

- **Inspection Procedure 87100**, "*Licensed Materials Programs Program Applicability: 2800.*" This inspection procedure is used to determine if licensed programs are being conducted in accordance with NRC requirements and ensure the health and safety of workers and the general public. As part of this overall procedure, the inspector examines storage areas in unrestricted and restricted areas to see if such storage areas are locked and have limited and controlled access. In general, there will be procedures for access controls. The inspector should also determine if additional controls, such as logging out radioactive material from storage areas and logging it in after use are instituted. NRC noted that this is especially important for medical institutions because of the use of small implant seeds for therapy. The inspector also should determine that radioactive storage devices and source changers are locked when in storage and that storage areas also are locked when not in use.

- **Inspection Procedure 87110**, "*Industrial/Academic/Research Programs.*" This is used to determine if licensed programs are being conducted in accordance with NRC requirements and ensure the health and safety of workers and the general public. As part of this overall procedure, the inspector verifies that:

  -- Waste is stored and controlled in a secure and safe manner, and that radiation levels in unrestricted areas surrounding the storage area do not exceed the limits of 10 CFR 20.1301, "Dose limits for individual members of the public." Verify that disposals of decay-in-storage waste are performed in accordance with the regulations and license conditions. (Note that licensees, other than medical, must be specifically authorized in the license to dispose of waste by decay-in-storage.) Verify that the licensee is conducting appropriate surveys and defacing radioactive material labels before disposing of the waste.

  -- The licensee has an accounting system that suits the type of licensed program. For example, a relatively small facility will generally need to maintain receipt records, disposal records, and records of any transfers of material. However, a large facility will need a sophisticated accounting system for all licensed material that provides accurate information on the receipt, location, the quantity used and disposed of, the amount transferred to other laboratories operating under the same license, and the amount remaining after decay. The accounting systems should also consider licensed material held for decay-in-storage, near-term disposal, or transfer to other licensees. In both types of accounting systems, the licensee should perform routine physical audits, to ensure the accuracy of the system.

  -- The licensee's procedures and records are sufficient to document that each shipment of radwaste intended for offsite disposal is accompanied by a shipment manifest that includes all the required information.

  -- The licensee's procedures and records are sufficient to document that each package of radwaste intended for shipment to a licensed land disposal facility is labeled, as appropriate, to identify it as Class A, B, or C waste (in accordance with the classification criteria of 10 CFR 61.55 [Subsection III.A.2 of Appendix F to 10 CFR 20.1001-20.2401]).

-- The waste-handling equipment, monitoring equipment, and/or administrative controls are adequate to maintain radioactive effluents within the limits established by the license and other regulatory requirements and are ALARA, and that the licensee's air effluents, excluding Radon-222 and its daughters, have not exceeded the constraint limit in 10 CFR 20.1101. If the licensee has exceeded the constraint, the inspector verifies that the licensee has notified the NRC as required by 10 CFR 20.2203. If the licensee has notified the NRC that its air effluents have exceeded the constraint limit, the inspector reviews the effectiveness and timeliness of the licensee's corrective actions.

-- The quality of the relevant procedures and the degree to which ALARA techniques are incorporated into them, and the extent to which process and engineering controls are used to minimize effluents.

-- The effluent monitoring systems and the associated analytical equipment are adequate to detect and quantify effluents with sufficient sensitivity, and whether they are maintained, calibrated, and operated in accordance with manufacturers' recommendations and good health physics practices.

-- All significant release pathways are monitored, all un-monitored pathways have been characterized, and all surveillance procedures for effluents are being implemented.

-- The wastes are transferred to an authorized recipient specifically licensed to receive radioactive waste and that records of waste storage, transfer, and disposal are maintained in accordance with the requirements of 10 CFR Part 20 and the license.

- **Inspection Procedure 87110A**, "*Industrial/Academic/Research Inspection Field Notes.*" This inspection procedure is actually the form that the inspector uses to document a 87110 inspection at industrial, academic, research facilities.

- **Inspection Procedure 87110G**, "*Medical Broad-Scope Inspection Field Notes.*" This inspection procedure is actually the form that the inspector uses to document a 87110 inspection at a medical facility that has a broad-scope license.

4.0 Summary of Past Compliance with NRC Regulations

To gain a better understanding of the radioactive waste (LLRW/MLLW) management issues confronting nuclear reactor facilities and radioactive material licensees, a variety of NRC-produced violation summaries for the years of 1993 through 1998 were investigated. All of these summaries are available on the NRC home pages or through the NRC Public Document Room in Washington D.C. and are included in Attachment 6 of this report.

4.1 Background

The NRC has direct regulatory oversight responsibilities for all nuclear reactor facilities and radioactive material licensees in those states that have opted to allow NRC to provide regulatory and licensing oversight; these states are referred to as Non-Agreement States. The NRC allows for all nuclear reactor facility and Non-Agreement State inspection or violations-related information (and correspondence) to be publicly available. The NRC, however, has very limited information on material licensees operating in those states that have an agreement with NRC to provide their own regulatory and licensing oversight; these states are referred to as Agreement States. Therefore, different sources of information were used to produce Exhibit 18 and Exhibit 19. A brief analysis of the collected information (and identification of sources) are presented below.

4.2 Material Licences in Non-Agreement States (22 States) and Nuclear Reactor Facilities

To develop Exhibit 18, the following reports were analyzed:

- Office of Enforcement Annual Report - Fiscal Year 1996, U.S. NRC, rev. 1/97

- Office of Enforcement Annual Report - Fiscal Year 1997, U.S. NRC

- Escalated Enforcement Actions Issued Since March 1996 for Material Licensees (Last updated August 11, 1998), U.S. NRC

- Escalated Enforcement Actions Issued Since March 1996 for Reactor Licensees (Last updated August 14, 1998), U.S. NRC

- Enforcement Actions and Significant Actions Resolved - NUREG 0940 (Yearly, quarterly, violations summaries for Material Licensees, Medical Licensees, and Reactor Licensees, U.S. NRC

- Inspection reports stored at the NRC Public Document Room (PDR), located through the PDR database

EXHIBIT 18

Summary of Enforcement Actions (EAs) and Violations Occurring in Non-Agreement States (1993 - 1998)

Facility Name	State	Date of Report	NRC Inspection Report No.	Type of Violations
Georgia Power Company	Alabama	10/1/93	50-424/93-20 and 50-425/93-20	Failure to document specific determinations required by 10 CFR 71.87 and CoC requirements for packaging using for Class C low level radioactive waste shipments.
Department of Veteran Affairs - Medical Center	California	8/21/95	030-01215/95-01	Unauthorized disposal of licensed material by release to the normal trash; research laboratory investigator lost track of I-125 liquid and material was accidentally disposed of in regular trash.
D&B Tool Company	Connecticut	inspection date: 12/11/96	EA 96-477 no inspection # provided	Violation of waste disposal agreement with a customer; D&B Tool Company refused to accept and dispose of radioactive waste produced by the customer.
Allied Signal, Inc.	Illinois	2/26/98	040-03392/98001 (DNMS)	Failure to perform a "Radioactive Waste Audit" for a period of one year; an audit is required by the Metropolis Works Management Assurance Program to ensure source material wastes are properly characterized and shipped to a low-level radioactive waste disposal site.
Zion Generating Station	Illinois	6/17/97	50-296/96021(DRS) 50-304/96021(DRS)	Exceeding the radiation limits of 49 CFR 173.424 for a shipment of radioactive materials, and failure to analyze waste streams annually to determine radionuclide scaling factors as required by procedures.
Ford Motor Company	Michigan	9/16/97	030-03004-821-971	Storage of low level radioactive waste in an unauthorized location (authorized location specified in material license) for over two years; waste was stored in Chemical Storage Building, Research and Engineering Center instead of Hazardous Waste Storage Shack.

EXHIBIT 18 (Continued)

Facility Name	State	Date of Report	NRC Inspection Report No.	Type of Violations
Kennedy Memorial Hospital	New Jersey	inspection date: 1/31/97	EA 97-006 no inspection # provided	Failure to allow for sufficient decay time (10 half-lives while in storage) prior to disposal of low level radioactive hospital waste in ordinary trash.
Merck Sharp and Dohme Research Laboratories	New Jersey	6/26/97	030-14680/97-001	The improper disposal of 880 microcuries of iodine-125 at a municipal waste incinerator and failure to perform a radiation survey of the package containing the material prior to releasing it for disposal.
Public Service Electric and Gas Company	New Jersey	7/20/95	95-05	Improper vent release of 25 gallons, over a 14 hour period, of radioactively contaminated steam and water to the environment; liquids originated from a liquid radioactive waste treatment system.
St. Joseph's Hospital and Medical Center	New Jersey	3/25/97	030-02526/97-001	Failure to: provide, through the Radiation Safety Officer (RSO), the required oversight of the radiation safety program; conduct required weekly surveys of waste storage area; perform the required iodine-131 air concentrations surveys in the therapy suite and waste storage area; and have RSO sign records of the leakage tests and quarterly inventories of sealed sources.
Consolidated Edison Company of New York, Inc.- Indian Point 2 Station	New York	6/23/95	50-247/95-16	Delivery of licensed material (bulk dry active waste) with excessive levels of radiation to waste processor; waste was within limits prior to shipment leaving site but above limits (375 millirem per hour on contact with outer surface of vehicle) when surveyed at waste processor. Waste shifting during transport was unaccounted for and caused excess radiation.

EXHIBIT 18 (Continued)

Facility Name	State	Date of Report	NRC Inspection Report No.	Type of Violations
Niagara Mohawk Power Corporation	New York	1/22/98	50-220/97-07 50-410/97-07	Four shipments of radioactive material in a manner contrary to NRC requirements. Radiation levels (within an occupied portion of the transport vehicle) were in excess of limits upon arrival of shipment at destination; the wrong material was shipped such that the radiation levels upon receipt were 4X higher than expected; on two occasions, material shipped to different locations than intended.
B.P. Chemicals	Ohio	12/16/97	040-07604-97002	Failure to implement QA/QC Plan for Pond Closure Project. Concerns that sludge mixing, sampling, laboratory analyses, and record keeping could not be proven to be adequate.
The Ohio State University	Ohio	10/23/97	030-02640/96003 (DNMS) 030-02640/97001 (DNMS)	Failure to dispose of accumulated radioactive waste. (Accumulation and long-term storage of unusable radioactive material.)
Alaron Corporation	Pennsylvania	6/3/98	030-30666/98-001	Wilful failure to dispose of waste at facility that had been in storage for more than two years. Initial NOV issued 4/11/97 for storage of 15 waste packages >2 yrs; in February 1998, found two of the initial >2 yrs packages and 83 new packages also being stored >2 yrs.
Applied Health Physics, Inc. (AHP)	Pennsylvania	3/29/96 9/27/96	EA 96-353 030-10859/95-002 030-06198/95-002	Storage of radioactive waste for more than 180 days (which was a repeat violation); processing radioactive material which AHP was not authorized to possess; and NRC's concern about the financial status of the licensee and the possibility of abandoned radioactive material at the facility.

EXHIBIT 18 (Continued)

Facility Name	State	Date of Report	NRC Inspection Report No.	Type of Violations
Corning Clinical Laboratories	Pennsylvania	3/12/96	030-30859/96-001 030-19983/96-001	Failure to: dispose of radioactive materials by required procedures prior to closing facility; follow radioactive waste disposal procedures for solid radioactive waste; perform personnel surveys; perform radioactive waste surveys; train individuals; maintain disposal records; and maintain wipe test results in the units specified in 10 CFR 20.1005.
Geisinger Medical Center	Pennsylvania	7/3/96	030-02984/96-001	Two examples of failure to maintain complete and accurate information concerning the amount of radioactive material in a particular container, as well as whether a survey had been done prior to disposal of certain waste.
Lower Bucks Hospital	Pennsylvania	12/12/96	070-02792/97-001	Failure to properly track and control nuclear pacemakers that were explanted by other hospitals; the peacemakers were not returned to supplier and subsequently disposed of improperly or buried with patients.
Memorial Hospital	Pennsylvania	10/17/94	030-08366/94-001	Failure to dispose of radioactive waste in designated labeled, and properly shielded receptacle; failure to measure radioactive waste held for decay-in storage in low background area; failure of record of decay-in-storage to contain required information.
The Pennsylvania State University	Pennsylvania	12/30/96	EA 96-499 030-00952/96-001	Failure to secure licensed waste material or limit access to material at facility; unsecured material included liquid waste containing 6-millicuries of chromium-51 located in an unrestricted area. Failure to provide HAZMAT training within 90 days, for employee handling waste/material.
Hospital San Pablo	Puerto Rico	12/23/97	52-21325-01/97-01	Failure to secure licensed material from unauthorized removal; unauthorized disposal of licensed materials (disposed of as ordinary biomedical waste and incinerated), failure to monitor, with a radiation survey meter, radioactive waste held for decay-in-storage prior to disposal.

EXHIBIT 18 (Continued)

Facility Name	State	Date of Report	NRC Inspection Report No.	Type of Violations
Hospital San Pablo	Puerto Rico	12/23/97	52-21325-01/97-01	Failure to secure licensed materials from unauthorized removal; unauthorized disposal of the licensed materials; and failure to monitor, with a radiation survey meter, radioactive waste held for decay-in-storage prior to disposal.
Washington Hospital Center	Washington, D.C.	5/5/97	EA 98-145 no inspection # provided	Unauthorized disposal of radioactive waste, failure to secure waste, and failure to label waste. No additional information provided.
S.C. Johnson & Sons, Inc.	Wisconsin	9/4/97	030-06740/96001 (DNMS) Inv. Rpt. 3-96-053	Four violations were identified: unauthorized disposal of licensed material, removal of licensed material from service by unauthorized persons, inadequate security of licensed material, and failure to report lost or missing licensed material in a timely manner. Unauthorized disposal occurred as a result of improper storage of nuclear gauges, poor judgement on part of plant personnel participating in scrapping program, and inadequate direction provided to staff regarding the scrapping program.
St. Joseph's Hospital	Wisconsin	10/22/96	030-003406/96-001	Failure to dispose of low level I-131 dry waste properly; licensee disposed of waste by releasing it to the normal, non-radioactive trash.
Frontier Production Logging, Inc.	Wyoming	11/7/97	030-20586/97-01 Inv. Rpt. 4-97-023	Failure to file the appropriate documentation to receive NRC approval prior to vacating an authorized radioactive material storage location and properly posting areas in which licensed radioactive materials are stored.
DAW, Inc.	Incomplete information	1/5/93	50-485-92-28	Failure to properly label boxes containing soils contaminated with low levels of radionuclides; minor violation since no significant exposure occurred. Boxes should have been labeled, "No Label Required".

These reports list and describe a variety of different types of violations and EAs taking place in the last five years. The three primary types of enforcement actions available to the NRC are: Notices of Violation (NOV), civil penalties, and orders. A NOV identifies a requirement and how it was violated. A civil penalty is a monetary fine. An order modifies, suspends, or revokes licenses or requires specific actions by licensee or persons. As part of the enforcement process, the NRC assess the severity of violations. Severity Levels range from Severity Level I, for the most the significant violations, to Severity Level IV for those of more than minor concern. Minor violations are not subject o formal enforcement action. The reports listed above generally do not include Severity Level IV violation information due to their relative public health and regulatory unimportance. See NUREG-1600, Rev.1, "General Statement of Policy and Procedures for NRC Enforcement Actions," to understand NRC's enforcement policy. A copy of this document is attached as Attachment 7.

4.2.1 Analysis

In developing Exhibit 18, any violations that dealt with storage, disposal, and management of radioactive waste were selected for further review. Any violations that dealt with the loss or misplacement of radioactive materials, or components containing radioactive materials (e.g., gauges), that had not specifically been identified as a waste were excluded. As shown in Exhibit 18, the majority of violations occurred at material licensee sites (23); only five violations were noted at nuclear power facilities. Of the five minor violations which occurred at nuclear reactors, four of them dealt with packaging or shipping of wastes and one was related to an accidental release of contaminated waste water. None of nuclear reactor violations in the last five years were associated with the improper storage or disposal of radioactive wastes. This indicates that nuclear reactors are abiding by NRC radioactive waste management regulations.

In regard to material licensees, however, several licensees were cited multiple times for violations regarding improper radioactive waste disposal, storage and auditing (surveying) practices. Material licensees in Exhibit 18 essentially fall into three different categories: academic institutions, medical institutions, and private industry. Of these three different categories, medical institutions had the most violations (11). These violations dealt primarily with the improper disposal of LLW. Of the 23 material licensee violations, only two of these dealt with failures to abide by storage time limitations (e.g., storing LLW for longer than 180 days).

4.3 Material Licensees in Agreement States (30 States)

To develop Exhibit 19, the following reports were analyzed:

- Integrated Materials Performance Evaluation Program (IMPEP) NRC Reviews for: Arkansas (1998), Louisiana (1996), Iowa (1996), Illinois (1997), Georgia (1996), Maryland (1996), Colorado (1997), North Carolina (1995), New Hampshire (1997), Nevada (1997), California (1996), Nebraska (1996), Mississippi (1997), North Dakota (1996), Tennessee (1996), Utah (1994), Texas (1997)

EXHIBIT 19

Partial Summary of Enforcement Actions (EAs) and Violations Occurring in 5 Agreement States

(Information obtained from Appendix F in the "Integrated Materials Performance Evaluation Program" Reports performed by the NRC every Two years - not every state reported applicable violations for this summary)

Facility Name	State	Date of Event	License Number	Type of Violations
Amgen Incorporated	California	5/23/96	3768-56	Two vials of I-125 (101 microcuries) inadvertently disposed of in ordinary trash.
Aoki Diabetes Research Institute	California	8/23/96	5422-34	Improper disposal of radioactive waste (2 microcuries of I-125); employee disposed of waste down sink.
EMC	California	11/17/95	3546-50	Two liquid drums of LSA waste were either misplaced, lost, or stolen from a warehouse.
Korean Airlines	California	5/3/95	50395	Airlines called waste management firm to dispose of container marked "Radioactive Material" which was mistakenly stored at airlines freight area. Material was identified and shipped to the original licensed recipient instead.
NDC Systems	California	2/5/96	1451	Licensee removed container of Americium-241 from storage container for leak testing prior to shipping for disposal. During the leak testing procedures it was discovered that sources were leaking; site and personnel contamination occurred.
Orange County Sheriff-Coroner Department	California	6/17/96	R00067	P-32 waste was inadvertently disposed of as biohazardous waste. Material had accumulated over a four month period and containers with waste were accidentally transferred to biohazardous waste holding area and picked up by off site vendor.
UCLA	California	3/16/95	1335-70	Waste, which exceeded allowable limits (5microRem/hr at surface), from UCLA sent to incinerator company.
Veterinary Tumor Institute	California	10/1/93	4647-44	Radioactive material found in waste container (55 gallon fiberdrum) used to collect medical sharps.

EXHIBIT 19 (Continued)

Facility Name	State	Date of Event	License Number	Type of Violations
Virginia Medical Center	California	3/23/93	Not reported	BFI, a waste management firm, received waste barrel from VA. Center with a reading 1000 microRem/hr above background.
Becton Dickinson	Georgia	5/31/94	NA	Cases of Bactec test kits and bacteria culture media were found in trash area at the storage warehouse (288 microcuries/case of C-14).
Emory University	Georgia	9/14/95	GA 153-1	Waste from Emory set off the monitor at the landfill; material turned out to be 75 microcuries of I-131 in urine sample.
Kerr-McGee	Illinois	3/31/95	STA-583	Construction workers discovered a bottle of radioactive materials buried on the property adjacent to the current licensed site. License holder claimed responsibility.
Midwest Metallics	Illinois	8/24/96	Non-licensee	Scrap broker reported that a contaminated load of scrap had been received from another broker; material was identified as vials of uranyl-nitrate powder and a piece of uranium ore.
Union Pacific Railway	Illinois	7/3/96	Non-licensee	Train carrying soil contaminated with thorium derailed. The shipment was in route to Envirocare, Utah from a DOE clean-up site in New Jersey.
Montgomery County Solid Waste Transfer	Maryland	8/96	MD33-037-01	"Hot trash" set off radiation monitor at waste transfer station. County office building trash had been contaminated by county employee who had recently received radiation treatment therapy.
Sacred Heart Hospital	Maryland	4/13/94	MD01-002-02	Discarded lead pig and vial containing radioactive label found on local street in Cumberland, MD by Columbia Gas. Co. representative; hospital failed to follow standard disposal procedures.
Mary Hitchcock Memorial Hospital	New Hampshire	5/15/96	NH-130R	Bag of contaminated wastes (155 microcuries of I-131) was removed from patient's room and sent to landfill along with "normal' trash. Contamination was found in patients room.

EXHIBIT 19 (Continued)

The NRC implemented the IMPEP in 1995 to evaluate their Regional materials program and the Agreement State radiation control programs. NRC reviews Agreement State every two to four years. Specific evaluation criteria (or performance indicators) are used during the evaluations which serve to ensure consistency in the nation's materials safety program. As part of IMPEP, the NRC also reviews the Agreement States' material inspection program and Appendix F of each IMPEP state review document presents a collection of violations or enforcement actions that occurred within the specific Agreement State during the reporting period.

These violations are recorded as result of performing inspections on material licensees. The listing of violations can vary in length (7 listings to as many 45) and in quality of descriptions (one line to a full paragraph). The violations included in Appendix F are chosen by the NRC staff while visiting the State which is undergoing the review. In some cases, the compiled violations list is representative of most of types of violations occurring in the state, and in other cases the NRC staff simply chooses violations that are relevant to a particular topic of interest to NRC at that time (i.e., the list is not all inclusive).

In addition to reviewing NRC's IMPEP review reports, five states were contacted directly to request a more comprehensive summary of violations. Four of the states stated that they had no publicly available reports on violations; the fifth state did not respond.

4.3.1 Analysis

Again, in developing Exhibit 19, any violations that dealt with storage, disposal, and management of radioactive waste were selected for further review. Violations that dealt with the loss or misplacement of radioactive materials, or components containing radioactive materials (gauges), that had not specifically been identified as a waste were excluded. From the information found in 17 IMPEP state reports reviewed, only five states had a total of 17 violations that involved problems with storage or disposal of radioactive waste. The majority of these violations (10 of 17) dealt with the improper disposal of waste. Specifically, low activity waste was simply disposed of in the "normal" waste streams instead of following proper disposal procedures for radioactive waste. As was the case with Non-Agreement States, medical institutions had the most violations. There were no instances where radioactive waste had been stored longer than the allowable period.

4.4 Comparison of NRC Violations to RCRA Violations

To provide a baseline for the comparison of NRC LLW violations, two of EPA's generator information management systems - - the Biennial Reporting System (BRS) and the Resource Conservation and Recovery Information System (RCRIS) - - were queried to obtain the number of RCRA violations. BRS is a national system that collects data on the generation, management, and minimization of hazardous waste. BRS captures detailed data on the generation of hazardous waste from large quantity generators and data on waste management practices from treatment, storage and disposal facilities. These data are collected every other year and are reported by the facilities to EPA on even years about the hazardous waste activities of the previous year. This database was used to identify every facility that generated hazardous waste in 1995.

RCRIS was then used to obtain information on violations that occurred in 1995. RCRIS is a national program management and inventory system of RCRA hazardous waste handlers. Handlers can be characterized as fitting one or more of the following categories:

- Treatment, Storage and Disposal Facilities (TSDs)
- Large Quantity Generators (LQGs)
- Small Quantity Generators (SQGs)
- Transporters

RCRIS captures identification and location data for all handlers and a wide range of information on TSDs regarding permit/closure status, compliance with Federal and State regulations, and cleanup activities.

Using BRS data for 1995, 18,497 facilities were identified as having generated hazardous waste (including permitted small quantity generators). These "records" were merged with the information from RCRIS and then sorted by RCRIS violation area codes. The RCRIS violation area codes are presented in Exhibit 20.

EXHIBIT 20

Summary of RCRIS Violation Codes

Violation Area Codes	Violation Area Descriptions	Generator/TSD/Other
GER	Generator All Requirements	G
GLB	Generator Land Ban Requirements	G
CAS	Corrective Action Compliance Schedule	O
CSS	Compliance Schedule Violations	O
DCL	TSD Closure/Post-Closure Requirements	O
DFR	TSD Financial Responsibility Requirements	O
DGW	TSD Groundwater Monitoring Requirements	O
DOT	TSD Other Requirements	O
FEA	Formal Enforcement Agreement	O
BCE	BIF Standards to Control Emissions	T
BDT	BIF Standards for Direct Transfer	T
BIS	BIF Interim Status Standards	T
BPS	BIF Permit Standards	T
BRR	BIF Standards for the Regulation of Residue	T
DCH	TSD Chemical/Physical/Biological Requirements	T
DIA	Incinerator Waste Analysis	T

EXHIBIT 20 (Continued)

Violation Area Codes	Violation Area Descriptions	Generator/TSD/Other
DIN	TSD Incineration Requirements	T
DLB	TSD Land Ban Requirements	T
DMI	Incinerator Monitoring and Inspection	T
DOP	Incinerator Operator Requirements	T
DPS	Incinerator Performance Standards	T
DTT	TSD Thermal Treatment Requirements	T
TRR	Transporter All Requirements	TR

Key: G = Generator, O = Other requirements that apply to both storage and treatment facilities, T = Treatment, and TR = Transporter.

The violations were sorted by grouping (generator, other, treatment, and transporter) and by state to prepare Exhibit 21, which shows the number of RCRA violations by state in 1995.

EXHIBIT 21

Summary of RCRA Violations Cited for Generators that Treat and/or Store Wastes Onsite - 1995

State	No. of BRS Generators	No. of Facilities without Violations	Total No. of Violations	Breakout of Violations by Grouping				Total No. of Generator Violations Involving Mixed Waste
				Generator Violations	Treatment Violations	Other Violations	Transporter Violations	
AK	64	53	60	56	0	4	0	0
AL	239	197	154	122	3	29	0	2
AR	174	161	108	58	4	46	0	0
AZ	187	153	36	22	0	14	0	1
CA	1,574	1,554	37	14	4	19	0	1
CO	147	139	12	9	0	3	0	2
CT	379	358	94	82	0	12	0	6
DC	17	15	13	13	0	0	0	0
DE	63	48	76	72	0	4	0	3
FL	389	343	198	161	1	34	2	14
GA	366	287	340	238	5	97	0	0
GU	13	13	0	0	0	0	0	0
HI	47	47	0	0	0	0	0	0
IA	91	91	0	0	0	0	0	0
ID	45	41	11	3	1	7	0	0
IL	1,074	1,025	121	46	2	73	0	1
IN	563	482	237	157	10	70	0	13
KS	197	180	48	46	0	2	0	7
KY	383	359	59	35	1	23	0	0
LA	347	322	71	55	3	12	1	0
MA	462	445	86	78	0	5	3	7
MD	177	175	2	1	0	1	0	0
ME	145	135	59	59	0	0	0	0

EXHIBIT 21 (Continued)

State	No. of BRS Generators	No. of Facilities without Violations	Total No. of Violations	Breakout of Violations by Grouping				Total No. of Generator Violations Involving Mixed Waste
				Generator Violations	Treatment Violations	Other Violations	Transporter Violations	
MI	643	548	265	183	8	69	5	2
MN	273	255	38	25	1	10	2	0
MO	162	150	24	18	1	4	1	0
MS	138	126	26	22	1	3	0	0
MT	48	44	4	4	0	0	0	0
NC	504	500	9	4	0	5	0	0
ND	13	13	0	0	0	0	0	0
NE	61	59	5	5	0	0	0	0
NH	119	111	40	40	0	0	0	0
NJ	989	864	172	167	0	5	0	13
NM	41	24	82	71	5	6	0	39
NN	9	9	0	0	0	0	0	0
NV	74	71	25	23	0	2	0	14
NY	1,719	1,706	20	11	1	8	0	1
OH	1,215	1,033	798	586	12	200	0	0
OK	151	131	96	81	1	14	0	0
OR	204	173	170	81	2	87	0	0
PA	1,011	991	30	26	0	4	0	0
PR	66	66	0	0	0	0	0	0
RI	97	92	18	10	0	8	0	0
SC	357	338	52	40	0	12	0	0
SD	15	15	0	0	0	0	0	0
TN	460	374	199	174	10	11	4	0
TT	3	3	0	0	0	0	0	0
TX	1,295	1,241	168	124	11	32	1	0

EXHIBIT 21 (Continued)

State	No. of BRS Generators	No. of Facilities without Violations	Total No. of Violations	Breakout of Violations by Grouping				Total No. of Generator Violations Involving Mixed Waste
				Generator Violations	Treatment Violations	Other Violations	Transporter Violations	
UT	93	86	29	23	1	5	0	1
VA	337	329	14	8	0	6	0	0
VI	1	1	0	0	0	0	0	0
VT	72	59	56	52	1	1	2	0
WA	668	640	125	115	0	10	0	14
WI	391	372	43	41	0	2	0	0
WV	111	84	217	94	3	120	0	1
WY	14	14	0	0	0	0	0	0
Total:	18,497	17,145	4,547	3,355	92	1,079	21	142

As shown in Exhibit 21, a total of 4,547 violations were caused by a total of 1,352 facilities (or 7.3% of the 18,497 permitted facilities). Of the 4,547 violations, 3,355 resulted from the non-compliance with the generator requirements (manifesting, recordkeeping, time-in-storage, reporting, etc.), and of the 3,355 generator violations, 142 involved mixed waste. Although a direct comparison is not possible (because compliance information could not be obtained for every material licensee), it should be noted that the number of violations reported (on a percentage basis) by NRC for both nuclear power reactors and material licensees compares favorably with the percentage of violations reported by EPA. Attachment 8 presents the RCRIS output sorted by generator and state.

REFERENCES

10 CFR Chapter I -- Nuclear Regulatory Commission.
U.S. Nuclear Regulatory Commission, "Information Digest, NUREG-1350, Volume 9, 1997 Edition.

U.S. Environmental Protection Agency, Biennial Reporting System, Office of Solid Waste, 1995.

U.S. Environmental Protection Agency, Resource Conservation and Recovery Information System, Office of Solid Waste, 1995.

U.S. Nuclear Regulatory Commission, Generic Letter 85-14, "Commercial Storage at Power Reactor Sites of Low-Level Radioactive Waste Not Generated by the Utility," August 1, 1985.

U.S. Nuclear Regulatory Commission, Generic Letter 80-051, "Letter to Licensees Concerning On-Site Storage of Low-Level Waste," and Enclosure "Safety Consideration for Temporary On-Site Storage of Low-Level Radioactive Waste," June 9, 1990.

U.S. Nuclear Regulatory Commission, Generic Letter 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites," and Enclosure, "Radiological Safety Guidance for Onsite Contingency Storage Capacity," November 10, 1981.

U.S. Nuclear Regulatory Commission, HPPOS-239, "Clarification of Generic Letter 81-38, "Storage of Low-Level Radioactive Wastes at Power Reactor Sites."

U.S. Nuclear Regulatory Commission, IE Circular No. 80-18, "10 CFR 50.59 Safety Evaluations for Changes to Radioactive Waste Treatment Systems," August, 1980.

U.S. Nuclear Regulatory Commission, Information Notice No. 89-13, "*Alternative Waste Management Procedures in Case of Denial of Access to Low-Level Waste Disposal Sites.*"

U.S. Nuclear Regulatory Commission, Information Notice No. 90-09, "Extended Interim Storage of Low-Level Radioactive Waste by Fuel Cycle and Material Licensees," and Attachment, "Information Needed in an Amendment Request to Authorize Extended Interim Storage of Low-Level Radioactive Waste," February 5, 1990.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84523, "Liquids and Liquid Wastes (Preoperational and Supplemental).

U.S. Nuclear Regulatory Commission, Inspection Procedure 65051, "Low-Level Radioactive Waste Storage Facilities".

U.S. Nuclear Regulatory Commission, Inspection Procedure 84524, "Gaseous Waste System (Preoperational and Supplemental).

U.S. Nuclear Regulatory Commission, Inspection Procedure 84101, “Radioactive Waste Management”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84522, “Solid Wastes (Preoperational and Supplemental).

U.S. Nuclear Regulatory Commission, Inspection Procedure 84722, “Solid Wastes”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84750, “Radioactive Waste Treatment, and Effluent and Environmental Monitoring”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84723, “Liquids and Liquid Wastes”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84900, “Low-Level Radioactive Waste Storage”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84724, “Gaseous Waste System”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 86750, “Solid Radioactive Waste Management and Transportation of Radioactive Materials”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 87110G, “Medical Broad-Scope Inspection Field Notes”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 84850, “Radioactive Waste Management - Inspection of Waste Generator Requirements of 10 CFR Part 20 and 10 CFR Part 61".

U.S. Nuclear Regulatory Commission, Inspection Procedure 88035, “Radioactive Waste Management”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 87110, “Industrial/Academic/Research Programs”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 87110A, “Industrial/Academic/Research Inspection Field Notes”.

U.S. Nuclear Regulatory Commission, Inspection Procedure 87100, “Licensed Materials Programs”.

U.S. Nuclear Regulatory Commission, Management Directive 8.6 - “Systematic Assessment of Licensee Performance (SALP).

U.S. Nuclear Regulatory Commission, NUREG-0800, “Standard Review Plan for the Review of Safety Analysis Reports for Nuclear Power Plants, LWR (Light Water Reactor) Edition,” July, 1981.

U.S. Nuclear Regulatory Commission, NUREG-1600, Rev.1, “General Statement of Policy and Procedures for U.S. Nuclear Regulatory Commission Enforcement Actions, Enforcement Policy,” May, 1998.

U.S. Nuclear Regulatory Commission, NUREG-SR1556, V1, “Consolidated Guidance About Material Licenses: Program-Specific Guidance about Portable Gauge Licenses”.

U.S. Nuclear Regulatory Commission, NUREG-SR1556, V2, “Consolidated Guidance About Material Licenses: Program-Specific Guidance about Industrial Radiography Licenses”.

U.S. Nuclear Regulatory Commission, NUREG-SR1556, V6, “Consolidated Guidance About Material Licenses: Program-Specific Guidance about 10 CFR Part 36 Irradiator Licenses”.

U.S. Nuclear Regulatory Commission, NUREG-SR1556, V7, “Consolidated Guidance About Material Licenses: Program-Specific Guidance about Academic, Research and Development, and other Licenses of Limited Scope”.

U.S. Nuclear Regulatory Commission, Policy and Guidance Directive 94-05, “Updated Guidance on Decay-In-Storage,” October 19, 1994.

U.S. Nuclear Regulatory Commission, Regulatory Guide 8.18 - “Information Relevant to Ensuring that Occupational Radiation Exposures at Medical Institutions Will Be As Low As Reasonably Achievable,” Revision 1, October, 1982.

U.S. Nuclear Regulatory Commission, Regulatory Guide 10.5 - “Applications for Type A Licenses of Broad Scope,” Revision 1, December, 1980.

U.S. Nuclear Regulatory Commission, Regulatory Guide 10.4 - “Guide for the Preparation of Applications for Licenses to Process Source Material,” Revision 2, December, 1987.

U.S. Nuclear Regulatory Commission, Regulatory Guide 10.2 - “Guidance to Academic Institutions Applying for Specific Byproduct Material Licenses of Limited Scope,” Revision 1, December, 1976.

U.S. Nuclear Regulatory Commission, Regulatory Guide 1.143 - “Design Guidance for Radioactive Waste Management Systems, Structures, and Components Installed in Light-Water-Cooled Nuclear Power Plants,” Revision 1, October, 1979.